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THE NATIONAL WATER POLLUTION PROBLEM AND IT'S CONTROL UNDER THE FEDERAL PROGRAM

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March 1964

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AND
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Prepared by:
Program Office
Division of Water Supply and Pollution Control

March 1964

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U.S. DEPARTMENT OF
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Public Health Service
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PREFACE

~~in the report~~

This staff paper contains the most recent compilation of information describing the national water pollution problem and the programs of the Division of Water Supply and Pollution Control under the Federal Water Pollution Control Act. It represents the most comprehensive statement available on the current status of those programs, and also contains an assessment of future needs and activities in this field. for 1964

With the passage of time, much of the statistical information contained herein will require revision and updating. Also, there will be changes in policy and programs. For the immediate future, however, it is believed that this document will provide a very useful background reference for personnel of the Division of Water Supply and Pollution Control and others concerned, and it is being issued for this purpose.

THE NATIONAL WATER POLLUTION PROBLEM AND ITS CONTROL
UNDER THE FEDERAL PROGRAM

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THE PROBLEM OF WATER POLLUTION

In the development of the Nation's vital water resources, the problems of water quality and water quantity are inextricably interwoven. Within the framework of this development, the control of water pollution has become, and for the foreseeable future will remain, the overriding consideration in providing adequate water supplies for continued national economic growth, health, and welfare.

It is not enough to have the right quantity of water - it must also be of the right quality to serve the many purposes for which it is needed. More water can be kept available for use by effective water pollution control than by any other means. In this way, water quality can be maintained for repeated reuse by each downstream community, industry, farm, and recreation area, thereby greatly increasing the capacity to serve of the available quantity of water.

Since 1945 the Nation has experienced a great population and economic growth. People and industry have spread to all parts of the country. New technologies have resulted in an amazing array of new products and with this, new industrial wastes. Agricultural practices have been changed by new chemical products, creating new pollution problems from land drainage. Other land drainage problems are being created by construction of highways, airports, streets, buildings and other hard-surfaces areas. These and other developments are national in scope and as a result, the problem of pollution is nationwide.

Water - The No. 1 Natural Resources Problem

Water has become the Nation's No. 1 natural resources problem. This has developed as a direct result of rapid population and industrial growth, new technologies, and changing land practices. We can no longer afford the wide-spread illusion that our water supplies are drawn from a limitless source. Just as we have had to do with our land, forest, and mineral resources, we must now take whatever steps are necessary to develop, conserve, and protect our water resources in order to meet the Nation's soaring needs for municipal, industrial, agricultural, recreational, hydropower, and navigational purposes, and for the propagation of fish and aquatic life and wildlife.

The Nation is not running out of water as is frequently heard; there is just as much water falling on this country now as there ever was. The fact is, water needs have grown to the amounts where we must recognize that the supply is exhaustible and must be properly managed, both as to quantity and quality, if it is to serve all the purposes for which it is needed.

Since World War II, the Nation's water resources have been the subject of important discussions by an impressive number of Federal committees and commissions set up by the Executive and Legislative Branches of the Government. Also, almost all the States have completed, have underway, or have authorized comprehensive studies of the water resources within their jurisdictions.

These studies, both Federal and State, are concerned primarily with the conservation and development of water resources for power development, flood control, irrigation, and navigation. Most of the planning effort until recently has been directed towards increasing and conserving the amount of water available for use. Not enough attention has been given to the all-important need of planning for the cleanliness of water. After all, pollution is as effective as a drouth in reducing the amount of water available for use.

Oversimplifying a very complex situation, the water resources problem confronting the United States from now on is one of making its relatively fixed supply meet a rapidly increasing demand by providing the right quantity of water of the right quality at the time and places where it is needed.

To meet needs we must develop our capturable water resources up to their maximum dependable amounts and pursue an aggressive, effective program of pollution prevention and control that will maintain a high level of water quality in the ground, lakes and streams across the country--the Nation's fresh water supply. We must do the same with respect to our valuable estuarine and coastal water resources.

Most of our present water pollution problems have been caused by their having received too little attention in the past. Many States have not been provided with program resources commensurate with their pollution problems and their role of primary responsibility in dealing with pollution. The Federal Government has dealt with the problem only in recent years and then on a small scale.

Many municipalities and industries have resisted constructing needed waste treatment works, regarding them as a benefit only to those downstream and as an unnecessary or inequitable financial burden. The public has been allowed to retain too much of the "water purifies itself every seven miles" philosophy. It has been oversold on the cheapness and plentifulness of water and undersold on the value and necessity for pollution control. The engineer has relied on the stream to do much of the waste treatment job rather than tailoring treatment to keep the stream as clean as possible.

The problems of water pollution have been brought into sharp focus by the speed of our population and industrial growth, a new and changing technology, new agricultural practices, and new contributions to a continually rising standard of living. We have been caught unawares by these developments so that we are relatively unprepared to deal with the resulting pollution problems sociologically, economically, legally or technically. The water pollution control administrators are attempting to manage the new, complex problems of today with tools that were designed for the problems of yesterday. The Nation is entering a critical water supply situation that requires immediate attention if it is to continue to move forward.

THE NATURE OF WATER RESOURCES PROBLEMS

There are six primary factors contributing to the national water resource problem:

1. The relatively fixed amount of the Nation's water supply;

2. The uneven way water is distributed geographically and seasonally by Nature;
3. The rapid growth of population, industry, and agriculture, which often do not locate where water is plentiful;
4. The concentration of population and industry in urban areas, and development of the metropolitan complex;
5. The enormous increase in water use by a growing population, industry, and agriculture; and
6. The very large increases in pollution resulting from population and industrial growth, new technology, and from changing land practices that are seriously impairing the quality of the national water resources.

The Relatively Fixed National Water Supply

For as long as records have been kept, the amount of water falling on this country has averaged 30 inches a year. Since the amount of precipitation is relatively constant, it follows that the Nation's fresh water supply is relatively fixed.

This fixed amount of precipitation averages about 4,300 billion gallons of water a day. Unfortunately, very little of this seemingly vast quantity of water is available for use. Seventy-two percent of it, or about 3,100 billion gallons, is returned to the sky each day by evaporation and by the breathing and perspiring of plants, animals, and man. Nor is all the remaining 28 percent, or 1,200 billion gallons, available for use. A large proportion of this occurs as flood water which quickly runs back to the ocean--gone before it can be used. The remainder is our water supply and by the nature of water, much of this returns to the ocean before it is used. An increasing amount of this water is spoiled by pollution.

Hydrologists have estimated that the total fresh water available today in the Nation's lakes and streams is about 315 billion gallons per day. It is estimated that by 1980 the total dependable fresh water supply can be developed to about 515 billion gallons per day. The maximum dependable supply that we can hope ever to develop by engineering works is estimated to be about half the average total run-off, or approximately 650 billion gallons per day.

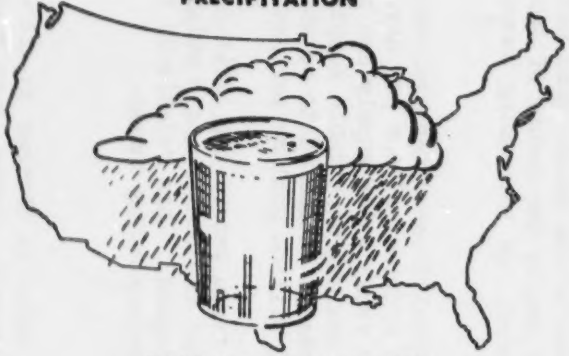
It is on these dependable supplies of fresh water, the limit of which appears to be 650 billion gallons a day, that the continuing population and economic growth of the United States must depend. This relatively fixed supply must be effectively managed to meet an ever-increasing demand.

Uneven Distribution of Water Resources

The uneven way Nature distributes our water is obvious to all who are familiar with our geography. We have our deserts, swamps, rain forests, humid regions, and semi-tropical areas. In Maine, rainfall averages 40 inches annually and only 15 are lost by evaporation. At the other extreme, Arizona receives only 14 inches of rain annually but 13 inches evaporate before they can be used. Roughly, about two-thirds of the annual rainfall is on the eastern half of the United States and one-third is on the western half.

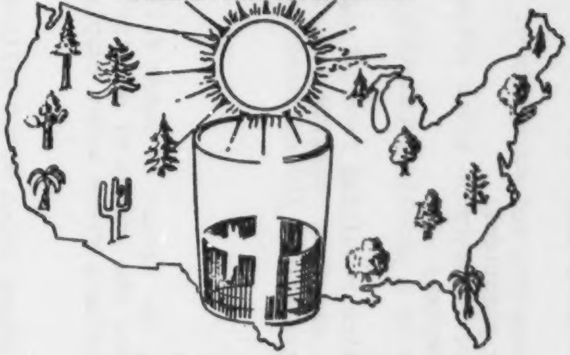
OUR FIXED FRESH WATER SUPPLY

PRECIPITATION



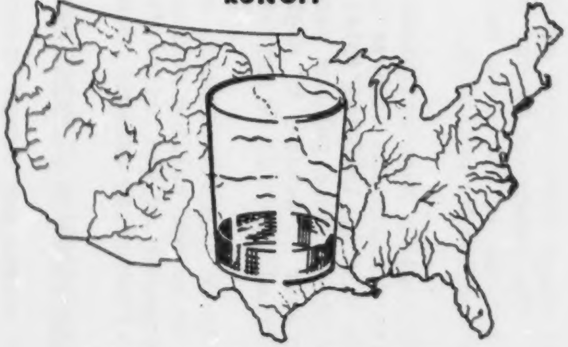
Precipitation averages about 4300 billion gallons a day

EVAPO-TRANSPIRATION



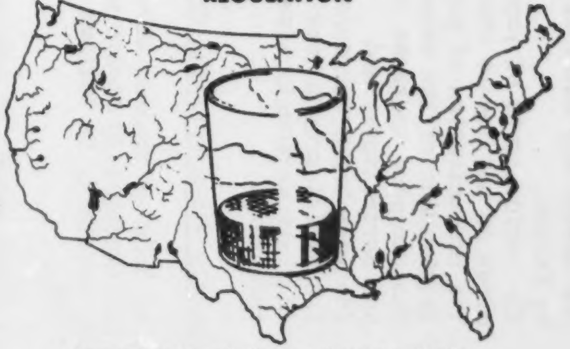
Seventy-two percent evaporates or is transpired, leaving 1200 billion gallons

RUNOFF



Most of the remainder is lost through floodwaters and normal runoff, leaving 315 billion gallons a day available now.

REGULATION



Impoundments and other practices can raise the dependable supply to 515 billion gallons a day by 1980 and eventually to a maximum of 650 billion. This is our relatively fixed water supply.

If all the water that falls on this country were to remain exactly where it fell, the water would be up to 11 feet deep along the coasts of Washington and Oregon, but at certain places in Arizona and New Mexico it would be scarcely one inch. Between these extremes, most of the eastern half of the United States would be under 30 to 60 inches of water and most of the western half would be covered by 5 to 25 inches.

The maldistribution of water is not only geographic, it is seasonal. In most parts of the country, most of the precipitation occurs during certain seasons, generally the spring and fall. Except in the highest mountainous areas, winter snow accumulations are lost during spring run-offs. Interspersed between periods of heavy rainfall are periods of limited or no rainfall when stream flows and ground water levels approach or reach their minimums. Drouths occur to further complicate the distribution picture; they may be of short or protracted duration, affect large or small areas, and occur in any part of the country.

Thus the water resources problem involves the fact that Nature does not always distribute our water supply where or when it is needed. This imposes the need for conserving by all possible devices the water which falls in both water surplus and water short areas, and for transporting water from areas of surplus to those of shortage.

Population and Industrial Growth and Distribution

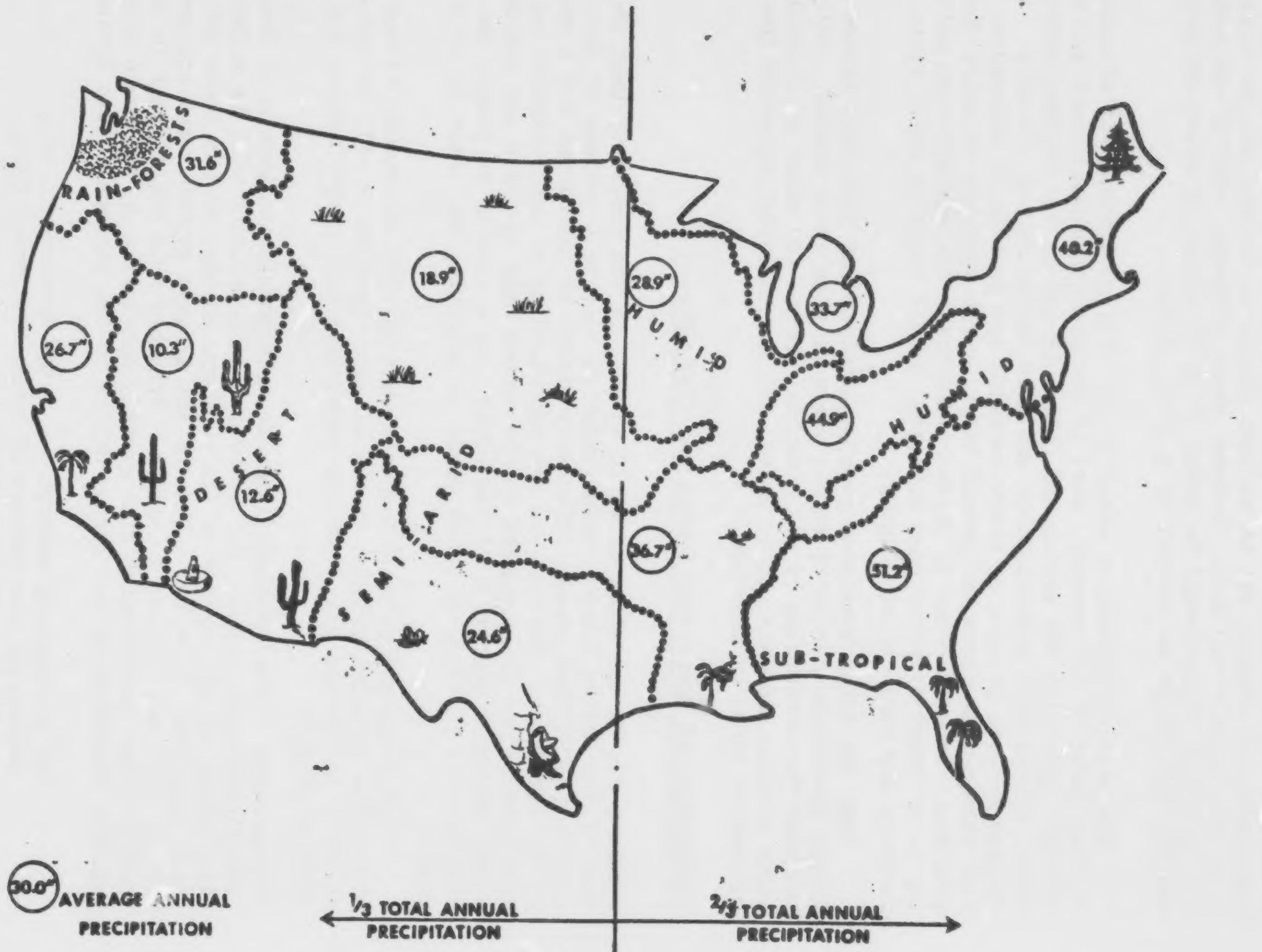
Population - At the close of World War II, it was predicted that the population of the United States would gradually rise to a maximum of about 170 million in 1975 and remain relatively static at that level for a good many years thereafter. Instead, we are experiencing an unprecedented population growth rate that is surpassed at the moment only by India and Communist China among the major countries of the world. As a result, we passed the 170 million mark in 1957, 18 years ahead of schedule, and there is no let-up in sight.

Population projections indicate that by 1970 the number of our people will range from 204 million to 220 million, by 1980 it will be 232-274 million, and by the year 2000 our population will range between 330 million and 430 million.

Urbanization - Just as significant as this population growth is the population distribution trend. The increases in population will be rather well-distributed in all regions of the country, whether or not there are adequate water resources there now. Some of the largest growth rates are predicted for our arid and semi-arid regions. Probably most significant is the trend towards urban living which will greatly accelerate in the years ahead. This was well described by Dr. Luther Gulick in the National Civic Review:

> "We are passing through . . . the development of a widespread new pattern of human settlement known as the rise of the metropolis.
>
> "From now on most Americans will be born, grow up, live, work and die in great metropolitan complexes;

UNEVEN DISTRIBUTION of WATER by NATURE


RAIN-FORESTS
31.6"
26.7"
10.3"
DESERT
12.6"
18.9"
SEMI-ARID
24.6"
28.9"
HUMID
36.7"
33.7"
44.9"
HUMID
40.2"
51.2"
SUB-TROPICAL
30.0" AVERAGE ANNUAL PRECIPITATION
1/3 TOTAL ANNUAL PRECIPITATION
2/3 TOTAL ANNUAL PRECIPITATION

> some in the cities, some in the expanding suburbs, but mostly in urban surroundings. From now on we are an urbanized civilization."

By 1980, more than 90 percent of our population, 220 to 250 million persons, will live in cities and towns. More than half of these will live in urban cities of over 50,000 population, or will crowd into their suburbs. Unless some drastic change occurs, we can look forward in the year 2000 to vast super-cities that will stretch hundreds of miles along our coasts and the Great Lakes, and to "linear cities" that will line all the great rivers and major highways.

Serious water supply problems have resulted from, and will continue to be created by, our increasing urbanization. Only a few of our large cities are as strategically located with respect to a bountiful supply of fresh water as are Chicago, Cleveland, and Detroit on the Great Lakes, or St. Louis, Pittsburgh, and the Kansas Cities on the banks of great rivers. Indianapolis is an example of a city located where there is almost no water at all.

Los Angeles must bring much of its present supply a distance of nearly 300 miles and plans to go even further for its future needs. Denver will have to reach to the other side of a mountain range to get an ample supply. Even in the humid East, Boston had to go 75 miles to the Connecticut River watershed to find the water it needed. New York City first reached out to the Catskills for its water, then 70 miles away to the upper Delaware River. Ironically, one of the great rivers of America, the Hundson, flows past New York City's door, rejected because of pollution.

The problems of maldistribution of population and water supply will multiply with increasing urbanization. These have their solution but they are costly. We cannot move the metropolis to the water supply, so we must move the water supply to the metropolis.

Industry - The growth of industry in the United States has been phenomenal and this growth rate is expected to continue into the foreseeable future. During the period 1900-1950, industry increased its output of goods by 700 percent. During and since World War II industry has greatly accelerated its productivity and by 1980 is expected to more than double the 1950 figures--more than 14 times production at the turn of the century. With new technologies constantly being developed and increasing use of automation, one can only speculate on the volume of production and the kinds of products to be expected in the year 2000.

Industry has spread to all parts of the country. There are few communities today that do not have at least one industrial plant and seeking more. The distribution of industry is guided by many considerations--proximity to market outlets, raw materials, and labor market; availability and cost of transportation, power and water resources; tax climate; and so on. In some types of industry, the area where employees wish to work and play is a deciding factor, with water for recreation often being paramount.

Much industry is moving into or has been encompassed by the metropolitan complex. A large segment of water-using industry is racing to locate at the dwindling sites along our major water resources, particularly the Great Lakes, the Ohio River, and the lower Mississippi. Still another large segment of water-using industry is moving into the Southwest and other water-short regions where other advantages than water availability are overriding--for the moment at least.

The major trend is location of industry within the metropolitan complex. On the other hand industry is helping to create more complexes since it attracts the labor market and accompanying service groups. The decided trend of industry into water-short areas is important, however, and presents grave water supply problems, both for itself and the supporting communities.

For many years industry has developed most of its own water supply, and still does. However, there is a decided trend for the urban industry to look more and more to the municipality for its water supply needs, both quantity and quality. This trend is further increasing the municipal water supply problem, especially where there are existing or potential shortages from lack of supply or development, or both.

When industry locates in a water-short area, or contributes to a water shortage by its demands, it acquires or shares in the responsibility for solving the water resources problems created.

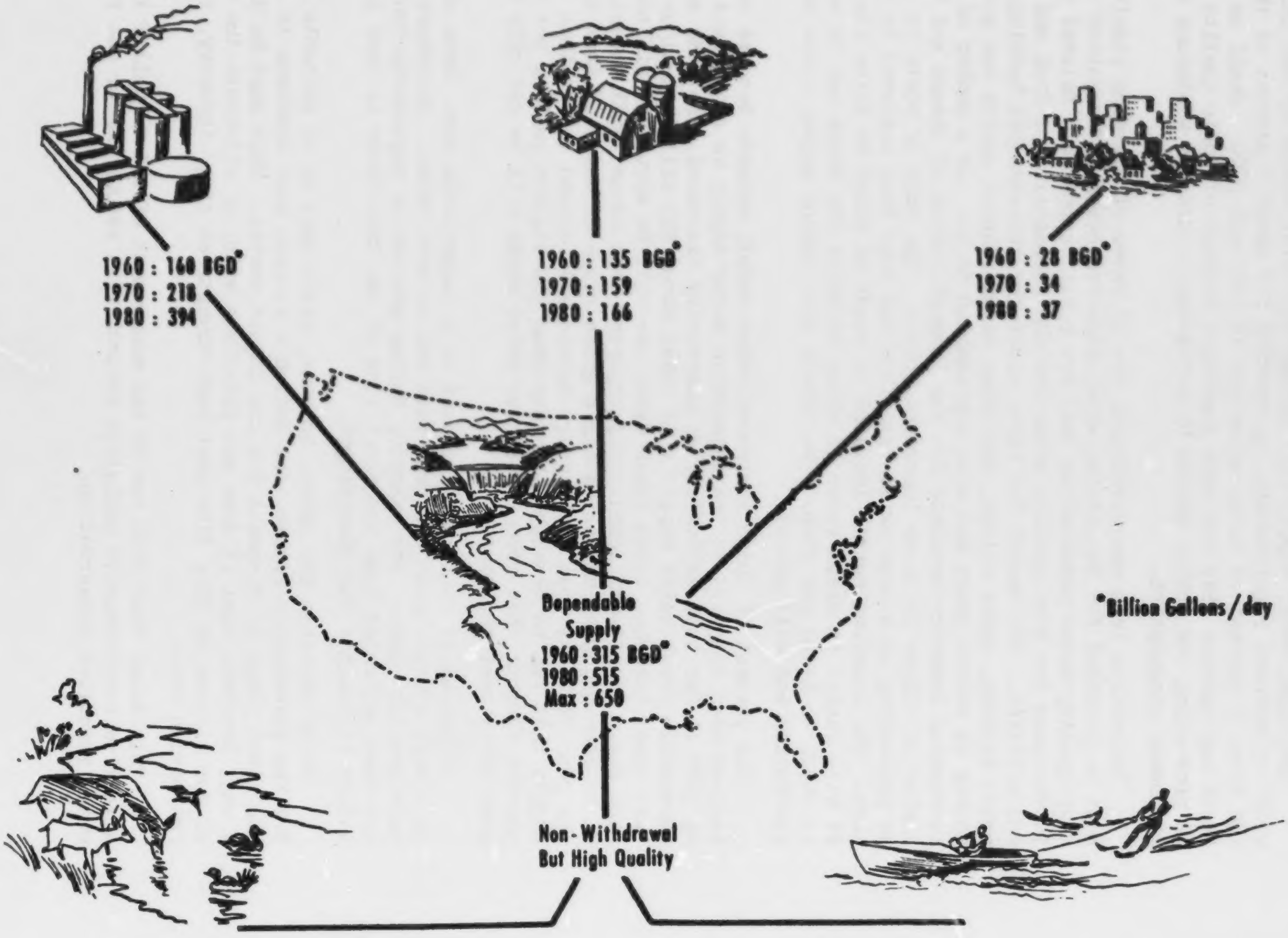
Increasing Water Use - Paralleling our explosive population and industrial growth, and directly related to it, is the increase in water use for all purposes. At the turn of the century, the United States was a rural nation with industrialization just beginning its rapid expansion. In 1900 the country used a total of 41 billion gallons of fresh water a day. In 1945, supporting the industrial effort required by World War II, we were using 150-160 billion gallons a day, which seemed then to be a vast amount. By 1954, total daily fresh water use had increased to 220 billion gallons and today it is approximately 355 billion gallons, more than double the 1945 use in only 18 years.

It is the projected estimates of future water needs that are causing grave and growing concern over our water resources. By 1980, in just 17 years, the projected fresh water needs will total 600 billion gallons per day, almost double the present daily water use. In view of estimated population and industrial growths, it is reasonable to predict that by the year 2000 our fresh water needs will total well over 1,000 billion gallons a day, another doubling of water needs in a 20 year period. Thus in only two generations we can expect our water needs to quadruple.

Industry will require 80 percent and more of these increases, and will account for 65 percent or over of all fresh water use in 1980 and 2000. This is not only because of rapidly-rising production but because many new technologies need more water than the old ones. For example, the manufacture of nylon, rayon, and other synthetic fibers requires several times as much water as is required to grow the natural fibers from cotton, wool, and silk which they are replacing.

Agriculture, particularly irrigation, will require the next largest segment of increased water needs, about 15 percent, and will account for about 28 percent and over of our total fresh water use in 1980 and 2000. A continuance of the trend towards supplemental irrigation in the East would drastically change these figures and have far-reaching effects on other water uses, relating both to water quantity and quality.

WATER USE: TODAY AND TOMORROW


1960 : 160 BGD*
1970 : 218
1980 : 394
1960 : 135 BGD*
1970 : 159
1980 : 166
1960 : 28 BGD*
1970 : 34
1980 : 37
Dependable
Supply
1960 : 315 BGD*
1980 : 515
Max : 650
Non-Withdrawal
But High Quality
*Billion Gallons/day

Municipal water supply will demand the least amount of our increased water withdrawal requirements, accounting for about 5 percent of the increases and about 7 percent of total water use in 1980 and 2000. Small as municipal needs may appear, they are most important because of their quality requirements in protecting the public health by providing a pure and wholesome water supply for human consumption.

Recreation is a non-withdrawal use of water of emerging significance that must be provided for in meeting water resource needs. Recreation requires a high-quality water paralleling that for public supplies. Related to recreation is the need for good quality water for the propagation of fish and aquatic life, and wildlife. The demand for clean water for recreational bathing, boating, sport fishing, water skiing, and other water-related sports has grown tremendously in recent years and will continue to do so. In a number of States the recreation industry accounts for the largest source of income and in a growing number of others it is an important source. The sale of boats in this country is proceeding at a more rapid rate than has ever been achieved by the sale of cars. The American public insisted on roads on which to drive its cars and it will insist on clean water on which to drive its boats and to water ski, and in which to bathe and fish. The public will demand ample, clean water for recreation and will get it.

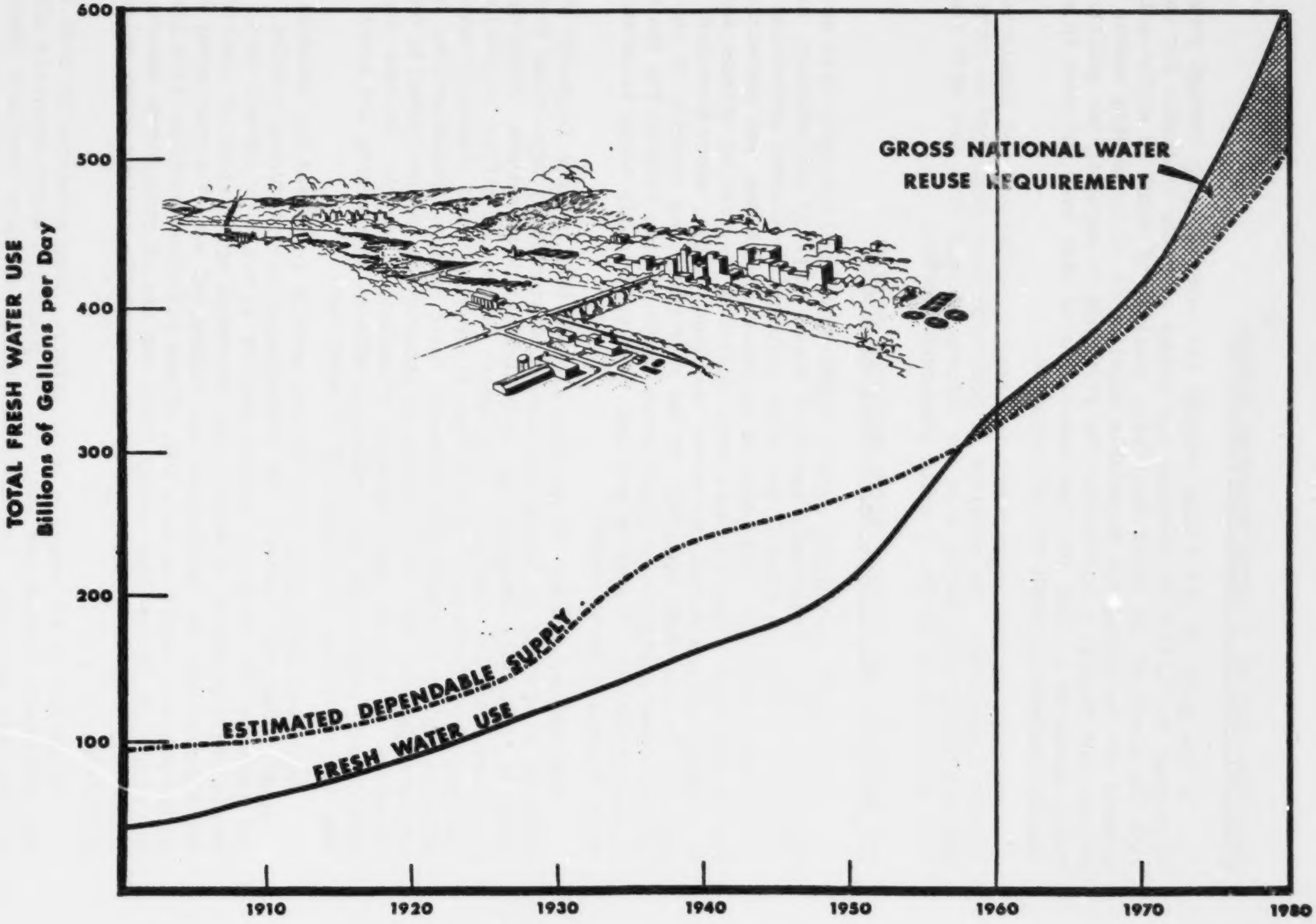
The portent of these increased water supply demands becomes exceedingly serious when compared to the dependable water supply we can expect to develop. By 1980 it has been estimated, as previously discussed, that the developed dependable fresh water supply will total about 515 billion gallons a day. By that time, however, total fresh water use will be about 600 billion gallons each day. It becomes immediately apparent that demand will exceed supply by 85 billion gallons, necessitating a gross reuse of water of that amount. In the year 2000 the toal fresh water demand will exceed the maximum dependable supply that can be developed by more than 350 billion gallons per day. It becomes obvious that from now on our water needs will be met only by using the same water over and over.

Actual water reuse is practiced on a large scale now. Some of the water in almost every stream has been used one or more times. In others there is a much greater reuse. For example, during periods of dependable low flows it has been estimated that the total flow of the Ohio River is used 3.7 times before it reaches the Mississippi.

To be suitable for reuse, however, water must be of suitable quality. For the foreseeable future, the Nation's streams must continue to function as the final place of disposal for its liquid wastes. This must be done in such a way, however, that it does not interfere with, or eliminate the use and reuse of our streams as they flow past each downstream city, industry, farm, and recreation area.

This means that from now on the management of water quality through effective comprehensive pollution control will assume number one priority in water resources conservation.

MULTIPLE WATER REUSE
A Necessity When Demand Exceeds Supply



POLLUTION--THE NO. 1 WATER RESOURCES PROBLEM

In the past, we met rising demands for water largely through construction of storage facilities to increase the amount of water available for use. Now, with the limit of the total dependable quantity of water in sight--actually demands are exceeding the dependable supplies in an increasing number of river basins--the highest priority must be given now to managing the quality of our water resources so that the same waters can be used over and over in meeting rapidly increasing needs for all purposes.

Implicit in this requirement is adequate, effective and timely pollution control nationwide. The problems of pollution have developed in scope, number and complexity much faster than our efforts to deal with them with the result that pollution is the No. 1 water resources problem.

THE NATURE OF THE NATIONAL WATER POLLUTION PROBLEM

In the past, pollution control authorities dealt largely with problems caused by sewage, industrial wastes of known toxicity and behavior, and natural organics. Pollution control was aimed principally towards protecting downstream public water supplies, abatement of nuisance conditions, and protection of fish and aquatic life. For the most part, dilution provided by streams was adequate to prevent serious pollution; waste treatment plants, where provided, were designed to take full advantage of the self-purifying capacity of the stream; and the water purification plant provided the safety barrier for the water-consuming public. Pollution problems were principally local in extent and their control a local matter.

National growth and change have altered this picture in recent years. Progress in abating pollution has been outdistanced by population growth, the speed of industrial progress and technological developments, changing land practices, and the consequent development of new and difficult problems. Population and industrial growth have figuratively and literally moved waste outfalls closer together and increased their number. Urbanization, increased living standards, and encirclement of industry by the municipality have increased the volumes and strengths of municipal wastes. In some communities, treated effluents today have polluting effects approaching and sometimes greater than the raw sewage discharges of 30 years ago.

Increased production of goods has greatly increased the amounts of "common" industrial wastes. New technologies are producing complex, new wastes and products that defy our current ability to treat or control them, or even detect their presence in water. The increased application of commercial fertilizers, and the development and widespread use of a vast array of new pesticides are resulting in a host of new pollution problems from land drainage. The growth of the nuclear energy field and use of radioactive materials foreshadow still another complicating and potentially serious water pollution situation.

Pollution is no longer a local affair. Long stretches of both intrastate and interstate streams are subjected to pollution which adversely affects their use for many purposes. Conventional biological waste treatment processes are hard-pressed to hold the pollution line and for a growing number of our larger cities, these processes are not adequate. There is growing concern over the ability of our water purification plants to adequately protect the public health against the sheer mass of biological and chemical pollutants entering their intakes.

Pollution is still a local affair with respect to the growing pollution of ground waters, although it is often an intermunicipal and sometimes interstate matter. Our exploding population is concentrating in urban areas and constantly moving outward from the central cities into suburbia and exurbia. Severage construction has not matched either this growth rate or its movements. As a result, a large share of our population must rely on individual septic tanks for its waste disposal and in an increasing number of places, this has resulted in serious pollution of ground waters which often must serve this same population with water supply. Few metropolitan areas are escaping this serious public health problem.

Sea water intrusion is a growing ground water pollution problem in coastal areas. It is caused by excessive pumping of the fresh ground water which lowers the water table, allowing salt water to flow into the ground water aquifers. Already a widespread problem, it is now of particular significance in California, Maryland, New Jersey, Texas, and Long Island, New York. Oil field brine disposal practices also are causing salt pollution of ground waters, particularly seepage from so-called "evaporation" pits. This is a particular problem in the oilfields of the Midwest and Southwest.

Sewage and industrial waste oxidation ponds, and waste storage lagoons are often responsible for ground water pollution, especially when improperly located in permeable soils.

Although the practice is not yet in extensive use except for oil field brines, industry is beginning to look to underground strata as the answer to its problems of disposing of highly toxic and/or untreatable wastes. This is also being considered with respect to radioactive wastes. This practice should not be extensively pursued until much more is known of the geology and hydrology involved, and of the procedures which will insure that pollution of ground water aquifers at any time and distance from the disposal site will not result in particular hazard to public health.

Twenty-three States border on the ocean and their estuarine and coastal waters have been subject to serious and increasing pollution for many years. Many of our larger cities and industries are located along the coasts and discharge their wastes, treated and untreated, into adjacent estuaries, bays, harbors and onshore coastal waters. These waters are also subject to significant pollution from inland areas, transported into them by the drainage basins of the country.

Pollution of our onshore salt water resources is adversely affecting their recreational and shellfishery values and creating health hazards, reducing the value of water front properties, and may be affecting the finfishery resource, either directly or through a breakage in its food chain. With much of the future national growth predicted for coastal areas, the problems of pollution will get much worse unless positive control measures are provided. The certain prospect of increased numbers of nuclear-powered ships berthing in estuarine and harbor waters will create still another potentially hazardous public health situation.

Classification of Water Pollutants

Water polluting substances may be classified into eight general categories, each of which is somewhat unique in pollutional characteristics and effects: (1) oxygen demanding wastes; (2) infectious agents; (3) plant nutrients; (4) synthetic organic chemical exotics; (5) inorganic chemical and mineral substances; (6) sediments; (7) radioactive materials; and (8) heat.

Oxygen Demanding Wastes - These are the traditional putrescible organic wastes contributed by domestic sewage and industrial wastes of plant and animal origin (food processing, paper mill, vegetable tanning, etc.). Such wastes are subject to biological degradation, and when oxygen is present it will be consumed, whether it is supplied artificially as in a waste treatment process, or naturally as dissolved in a stream. Since fish and aquatic life depend on dissolved oxygen, oxygen demanding wastes are detrimental to their environment, and when all oxygen is consumed by such wastes, gross, septic pollution conditions result.

Infectious Agents - This category includes the disease-causing organisms which are carried into surface and ground water by sewage from municipalities, institutions and sanatoria, and by certain kinds of industrial wastes, such as tanning and abattoir. Such waterborne wastes may transmit the microbes causing enteric and viral diseases, intestinal disorders, and various infectious, either by consuming the water or coming in direct contact with it through recreational use and other activities.

Plant Nutrients - These are substances in the food chain of aquatic plant life, such as algae and water weeds, which support and stimulate their growth. Nitrogen and phosphorous are the two principal minerals involved but other trace elements are also important. These minerals are usually present in small amounts in natural waters but much larger amounts are contributed by sewage, certain industrial wastes, and drainage from fertilized lands. Biological waste treatment processes do not remove the nutrients--in fact they convert the organic forms of these substances into mineral form, making them more usable by plant life. Nutrients are fertilizers and stimulate intensive and estensive growths of water plants which often cause unsightly conditions, interference with water treatment processes, and unpleasant and disagreeable tastes and odors. When these plant growths die and decay, they cause secondary oxygen-consuming and taste-odor-producing pollution.

Synthetic Organic Chemical Exotics - These are relatively new pollutants of increasing concern, resulting from new chemical technology. Included in this category are detergents and other household aids, all the new synthetic organic pesticides, synthetic industrial chemicals of a wide variety, and the wastes from their manufacture. The number, variety and tonnages of these chemicals is increasing rapidly each year. As pollutants they are characterized by their toxicity or potential toxicity to fish and aquatic life and possibly humans, their often extreme stability and persistence in the water environment, their resistance to removal by conventional water and waste treatment processes, their ability to cause tastes and odors and fish-flesh tainting, and their interference with other water uses. Much more needs to be known about the toxicity of synthetic organic chemicals and entirely new treatment and/or control methods must be devised.

Inorganic Chemical and Mineral Substances - This category includes a wide variety of mineral and inorganic chemical wastes which result from mining and manufacturing processes, oil field operations, agricultural practices, and natural sources. It includes a vast array of metals, metal salts, acids, solid particulate matters, and many other manufactured chemical compounds, including by-product wastes. Irrigation practices in the western States leach vast amounts of minerals from the soil which seriously affect downstream water quality. Natural salt and gypsum deposits in the Southwest are a particularly serious source of mineral pollution which adversely affects or makes unusable large quantities of ground, stream, and impounded waters in that already water-short area. Oil field brines compound the salt pollution problem in the Southwest and are a problem also in the oil-producing midwestern States. Acids of a wide variety are discharged as wastes by industry but the largest single source is acid mine drainage, particularly from abandoned workings and tailings. Acid mine drainage is a major problem in the Ohio, Potomac, Delaware and Susquehanna River Basins, and a significant one in certain tributaries of the Mississippi River in Illinois.

Inorganic chemicals and minerals may interfere with natural stream purification; destroy fish and aquatic life; cause excessive hardness of water supplies; corrode expensive water treatment and industrial equipment, concrete and steel structures; increase commercial and recreational watercraft maintenance costs; and increase water treatment costs. Certain of the metals and their compounds, such as lead and the cyanides, are known to be toxic.

Sediments - Sediments are generally considered to be those inorganic particles of soils, sands and mineral matters washed from the land and from hard-surfaced areas of communities (streets, buildings, airports, etc.). While not as insidious in their pollutional characteristics as other pollutants, sediments are a major problem from the sheer magnitude of sediment load imposed on most of the Nation's streams. It has been estimated that suspended solids from sediments is at least 700 times the suspended solids contributed by sewage. Sediments fill stream channels and harbors, requiring expensive dredging, and fill reservoirs, reducing their capacities and useful life. They erode power turbines, pumping equipment and other structures; reduce fish and shellfish populations by blanketing fish nests, spawn and food supplies; and reduce sunlight penetration of waters, required by green aquatic plants which produce oxygen necessary to normal stream balance. Sediments greatly increase the treatment costs for municipal and industrial water supply, and for sewage treatment where combined sewers are in use.

Radioactive Substances - Radioactive pollution may result from the mining and processing of radioactive ores; from the use of refined radioactive materials in power reactors and for industrial, medical and research purposes; and from fallout following nuclear weapons testing. Radioactive water pollution is at a very low level at the moment, largely due to careful controls at the sources and the recent moratorium on nuclear bomb testing, now ended. With an almost certain increase in the use of radioactive substances for electric power development, powering of ships and for commercial and industrial purposes, there is posed a serious potential public health problem, physiologically and psychologically. Nuclear weapons tests in the atmosphere compound the problem. With careful controls the problem can be contained. However, since radiation is cumulative in humans, such controls must be affected for the total exposure in the human environment--water, air, food, occupation and medical treatment.

Heat - Tremendous volumes of water are used for cooling purposes by steam-electric power plants, steel mills, petroleum refineries, petrochemical plants and other industries. Most of this water, with the added heat, is returned to the lakes, streams and coastal waters from which it was withdrawn, thereby elevating their temperatures. Heat has the effect of a pollutant because it reduces the solubility of oxygen in water, thereby reducing the ability of the receiving water to assimilate oxygen-consuming pollutants and to support fish and aquatic life. Heat has a direct detrimental effect on fish and aquatic life by changing the physical environment. Some fish can tolerate only a very few degrees of temperature increase and a substantial increase can virtually eliminate normal aquatic life.

Heat also may have detrimental effects on waters stored in reservoirs. Summer temperatures heat up the surface layers in lakes and impoundments, causing the water to stratify with the cooler waters settling to the deeper layers. Decomposing vegetative matter from natural and man-made pollutants, deplete the oxygen from these cooler, lower layers with detrimental effects on aquatic life. When these oxygen-deficient waters are discharged from the lower gates of the dam, they may have serious effects on downstream aquatic life and the ability of the stream to assimilate downstream pollution.

Most wastes are mixtures of the above general categories of pollutants, thereby complicating the problems of their treatment and control. Municipal wastes usually contain oxygen-consuming wastes, synthetic organic chemicals, inorganic chemicals, sediments, etc. The same is true of many industrial wastes which may contain substantial amounts of heat from processes other than cooling. Land drainage usually contains substantial organic matter in addition to sediments; also radioactive substances and air pollutants washed from the sky, vegetation, buildings, and streets during rainfall.

The Extent of Pollution from Municipal and Industrial Wastes

Municipal Wastes - At the turn of the century 950 communities in the United States had provided sewers which served 24.5 million persons. Sixty communities provided some kind of sewage treatment for 1 million persons and the remainder discharged their wastes untreated. In 1900 the municipal wastes reaching streams had a pollution effect equivalent to the raw, untreated sewage from a population of about 24 million.

Since 1900 the number of communities served by sewers has increased to more than 11,000 and the number of persons served to 118 million. Over 7,900 of these municipalities have constructed sewage treatment works to serve 102 million people. At the same time, the amount of municipal pollution has increased because of growing population, obsolescence of older treatment plants, failure to construct needed sewage treatment plants, increased interception of industrial wastes by municipal sewers, and increased number of water-using devices in the home (multiple baths, garbage grinders, automatic laudries, etc.). At the end of 1959 the municipal sewage discharged into our streams, treated and untreated, was equal in pollutional effect to the untreated sewage from more than 75 million people, three times the amount in 1900.

The table on the following page shows the growth in the sewered population and the increase in municipal sewage pollution: also future conditions if the present rate of treatment works construction is maintained and if

Population Served by Sewers and Sewage Treatment*

1900-1980
(in millions)

Year	U. S. Population	Sewered Population	% of U.S. Population Sewered	Population Served by Treatment	% Sewered Population Served by Treatment	Sewered Population Discharging Raw Sewage	Population Equivalent Discharged 6/
1900	76	24.5	32.2	1.0	4.1	23.5	24.0
1920	106	47.5	45.0	9.5	20.0	38.0	40.0
1935	127	69.5	54.7	28.5	41.0	41.0	51.0
1950	151	80.0	53.0	54.0	61.0	26.0	60.0
1960	180	110.0	61.1	92.0	83.6	18.0	75.0
1970	214 1/	152.0	71.0	137.0 2/ 124.0 3/	89.0 2/ 81.6 3/	15.0 2/ 28.0 3/	78.0 2/ 85.0 3/
1980	259 1/	200.0	77.2	200.0 4/ 170.0 5/	100.0 4/ 85.0 5/	None 4/ 30.0 5/	70.0 4/ 114.0 5/

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* Data taken or extrapolated from "Modern Sewage Disposal," Federation of Sewage Works Assoc., 1938; 1962 Inventory of Municipal and Industrial Waste Facilities, USPHS; and unpublished data from Basic Data Branch, DWSPC, USPHS.

1/ U.S. Bureau of the Census, Series No. 2 Population Projection.

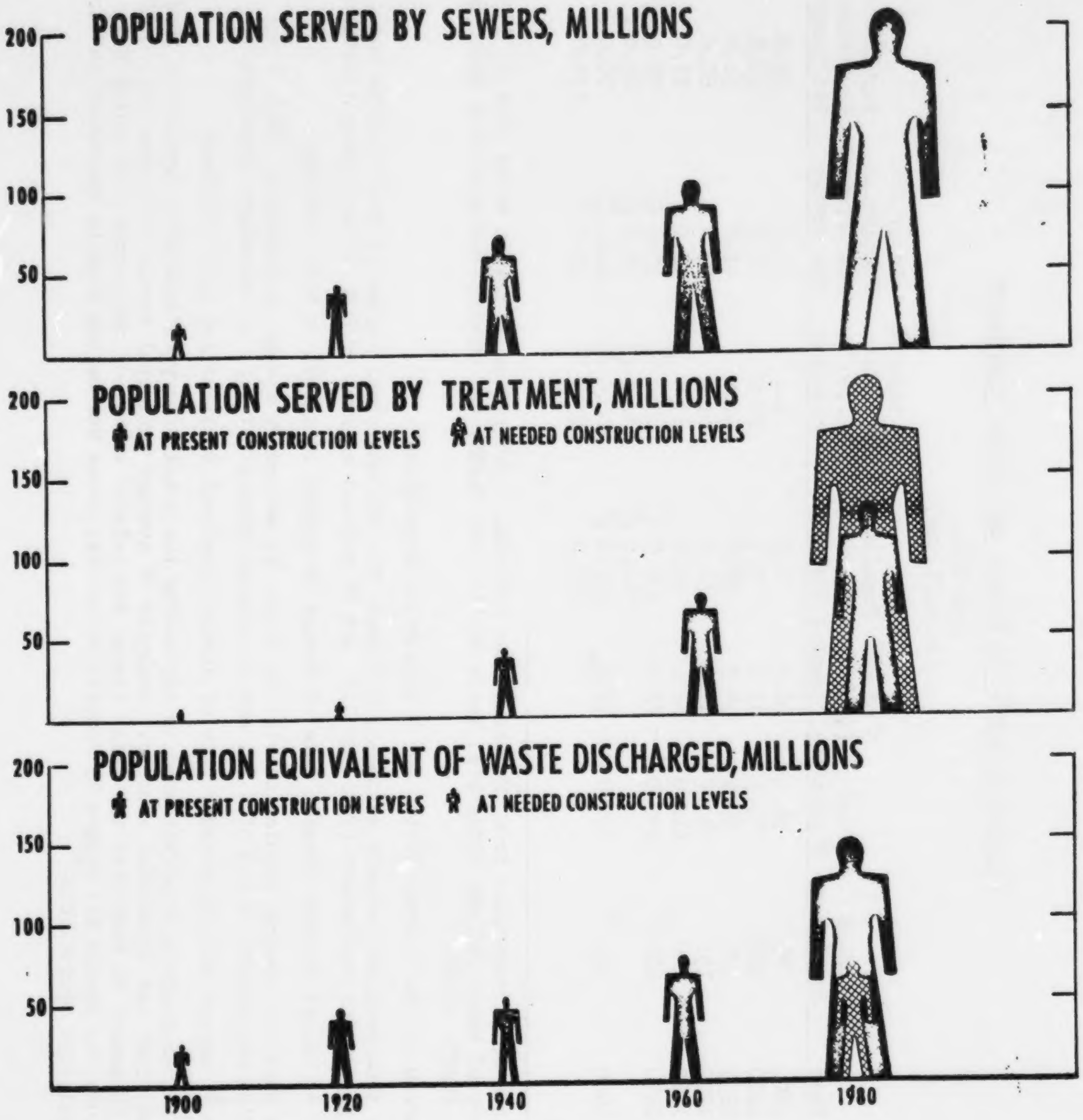
2/ Assumes that progress towards secondary treatment for all municipal wastes by 1980 will be made; a per capita population equivalent (P.E.) of 1.6; and 80 percent removal of P.E. by secondary treatment.

3/ Same as 2/ except assumes present rate of sewage treatment construction will continue.

4/ Assumes that all sewered population will be served by secondary sewage treatment by 1980; a per capita population equivalent (P.E.) of 1.75; and 80 percent removal of P.E. by secondary treatment.

5/ Same as 4/ except assumes present rate of sewage treatment construction will continue.

6/ Population equivalent is a unit used in expressing the total of oxygen demanding population loads from both municipal and industrial sources. Analysis of average municipal sewage indicates that 0.17 pound of oxygen is needed to stabilize the daily sewage and related wastes of one person. By using this figure to measure the demand for oxygen by industrial wastes, these wastes can also be expressed in terms of "population equivalents."


POPULATION SERVED BY SEWERS, MILLIONS
200
150
100
50
POPULATION SERVED BY TREATMENT, MILLIONS
AT PRESENT CONSTRUCTION LEVELS
AT NEEDED CONSTRUCTION LEVELS
200
150
100
50
POPULATION EQUIVALENT OF WASTE DISCHARGED, MILLIONS
AT PRESENT CONSTRUCTION LEVELS
AT NEEDED CONSTRUCTION LEVELS
200
150
100
50
1900
1920
1940
1960
1980

secondary treatment is provided by all communities by 1980. Projections for 1970 and 1980 are based on estimated urban growth rates and assumption that municipalities will continue to intercept acceptable industrial wastes.

The table shows that even if we provide secondary treatment by conventional methods for all the sewered population by 1980, the amount of municipal pollution reaching watercourses in 1970 and 1980 will be substantially the same as today. It shows also the amount of pollution that would be discharged if the present rate of municipal treatment construction continues. By inference, it can be seen what would happen should past apathy redevelop towards constructing needed municipal sewage treatment--intolerable water pollution situations would exist in many places before 1970 and would be nationwide long before 1980.

Pollution from Combined Sewer Systems - The discharge of mixed raw sewage and storm water into our streams from combined sewer system overflows is one of the most difficult water pollution problems confronting our urban areas today. The sewer systems in many of our older cities were developed in the 19th century before there was concern over pollution of the receiving streams and treatment of wastes. To the engineer of that day, it seemed logical to collect both storm water and sanitary sewage in a single combined system, since this provided marked savings in cost over a separated system.

During periods of rainfall, these combined sewer systems must carry many times their "dry weather flow" in mixed sewage and storm water. It has not been considered economically feasible to build treatment plants to handle the entire flow of rainwater along with the sewage and the alternative has been to design the systems to "bypass" the combined discharge above some predetermined level, usually 2 to 3 times dry weather flow, to a watercourse. Where municipal growth exceeds the original estimates, there will be an increasing demand on the combined system for just the sanitary sewage with little or no provision for storm water. Under these circumstances, there will be overflow even during light rainfall and during heavy rainfall a mixture of sewage and storm water equal to the runoff will be bypassed. Most plants for the treatment of wastes from combined sewer systems have been developed under a procedure in which 3 to 5 percent of the annual sewage flow is discharged directly to the stream, untreated, through combined sewage overflows. The storm water also washes large amounts of deposited sludge out of the sewers with the result that these overflows carry large amounts of pollution into the watercourses.

The effect of intermittent overflows of sewage on receiving waters must be considered in any assessment of the pollution problem. Even with complete treatment of dry weather sewage, the pollution discharged intermittently from storm water overflows can seriously impair the usefulness of a stream.

Unfortunately, few studies have been made to determine combined sewage composition and to evaluate the influence of combined overflows on stream pollution. Even where detailed studies have been made, the information is not applicable to other cities unless the precipitation pattern, character of the runoff area, capacity and design of sewer system, and conditions in the receiving waters are comparable.

However, those studies which have been made show that the overflow from combined sewer systems is unquestionably an important source of water pollution. There are more than 1,300 U. S. communities with combined sewer systems serving a population of 25.8 million at the present time. Another 630 cities of 33.1 million population have both combined and separate systems.

Organic Industrial Wastes - In 1900, pollution from organic industrial wastes (of animal or vegetable origin such as food processing, textiles, paper) being discharged directly to streams, in addition to those organic wastes discharged to municipal sewers, had a "population equivalent" of about 15 million people. In 1920, the population equivalent had risen to about 49 million persons. Studies and surveys by the U. S. Public Health Service in recent years indicate that the amount of organic industrial wastes, treated and untreated, now going into the Nation's watercourses is probably equivalent to the pollution from 160 million persons or about double the toal municipal waste load being discharged.

By 1975, industry is expected to double the production attained in 1950. This would indicate a possible doubling of present organic wastes by 1980.

The increase in organic industrial wastes discharged independently from municipal sewage systems since 1900 and estimated amounts in 1970 and 1980 are shown in the following table.

Increase in Organic Industrial Wastes

Year	Index of 1/ Industrial Production	Population Equivalent Discharged (In Millions)
1900	13	15
1920	26	49
1935	31	56
1950	75	100
1960	109	160
1970	156 2/	210 3/ 50 4/
1980	237 2/	310 3/ 80 4/

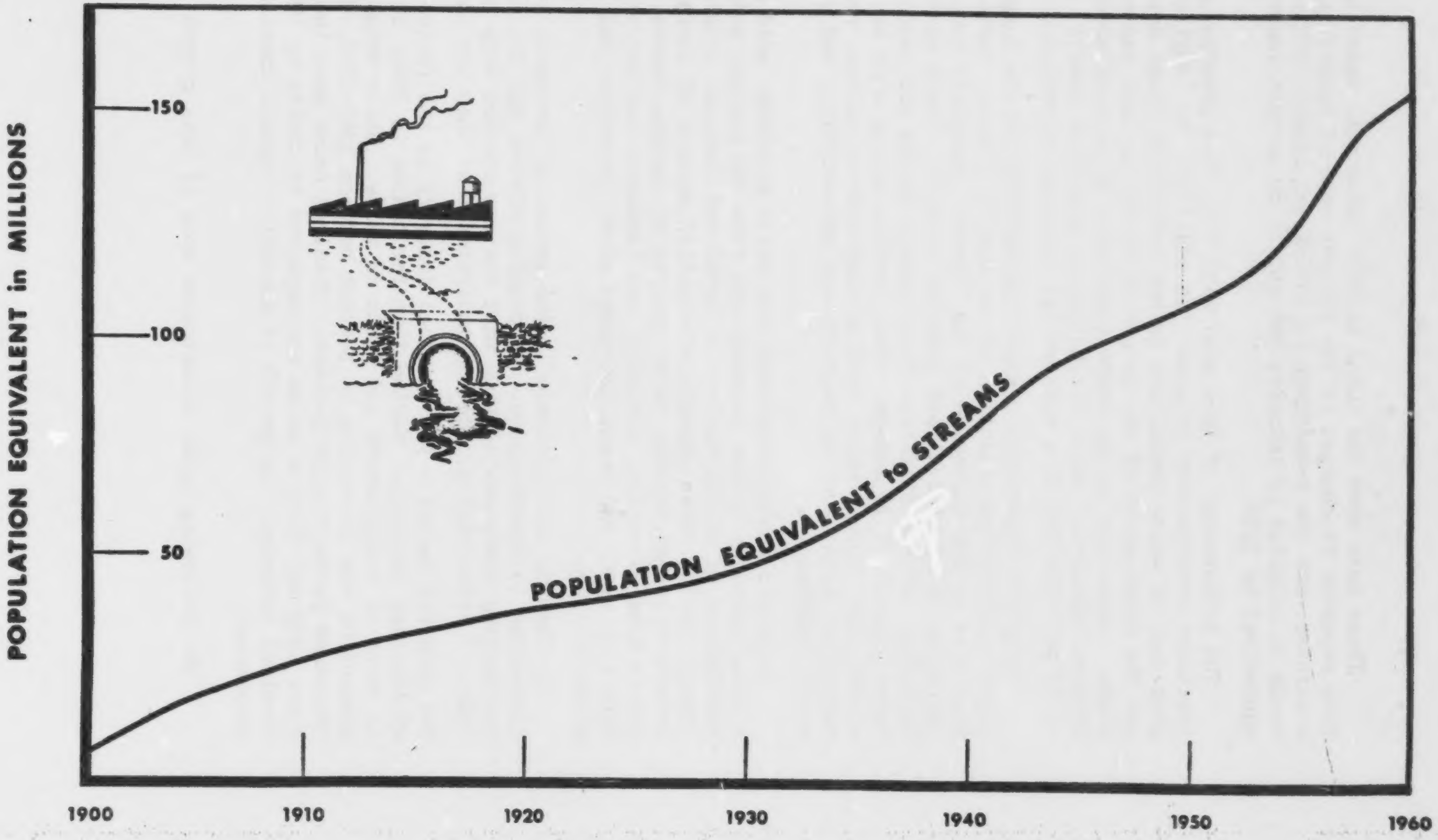
1/ Based on 1957-59 - 100; from Federal Reserve Board Index of Industrial Production.

2/ Estimated by National Planning Board, "National Economic Projections," from annual growth rate of 4.1 percent.

3/ Assumes estimated present rate of industrial waste treatment construction will continue.

4/ Assumes 80 percent removal of population equivalent by treatment will be obtained by 1980.

INDUSTRIAL ORGANIC WASTES
of
ANIMAL or VEGETABLE ORIGIN



These data show the total organic industrial waste load anticipated from separate discharges if the present rate of industrial waste treatment continues, and the reductions in industrial organic pollution loads which could be effected if industry can attain 80 percent removal of population equivalent by 1980.

The achievement of this goal will require a greatly accelerated waste treatment construction program. In addition, the "engineering out" of a good deal of waste production in new industrial plant design and construction and the development of new processes producing less wastes could reduce these loads. Reduction in the loads could also be accomplished by a trend to connect industrial waste discharges to municipal sewers, in which case this would be reflected in a substantial increase in municipal sewage loads.

Inorganic Industrial Wastes - In addition to the large increases in organic industrial pollution of the Nation's water, there have been large increases in the discharge of the "common" inorganic industrial wastes (principally of mineral and chemical origin). These wastes have polluting effects different from organic wastes and cannot be measured in terms equivalent to sewage. They contain metals such as iron, chromium, nickel, and copper; salts such as compounds of sodium, calcium, and magnesium; acids such as sulfuric and hydrochloric; and a host of other waste compounds.

Inorganic wastes originate from metal pickling, acid mine drainage, metal finishing, chrome tanning, and from the mining, processing, and manufacture of a wide variety of metal and chemical products. Even the organic wastes often contain substantial amounts of inorganic constituents. Inorganic wastes degrade water quality by causing tastes, odors, and color; excess mineralization, salinity, and hardness; and corrosion. Many interfere with water and waste treatment plant operation, and some are toxic or potentially so.

No figures are available on the amount of inorganic wastes being discharged to watercourses. Production figures for the industries discharging these wastes show that the amounts are very large and the index of industrial production indicates that they are increasing rapidly.

New Chemical Wastes - The chemical industry is the fastest-growing segment of American industry. Coming from far behind in 1900, it now ranks fourth in terms of total assets and fifth in sales. While total industrial p production was increasing 40 percent between 1947-1960, the chemical industry increased production 90 percent. Chemical sales have increased five-fold since 1939 and today's sales are expected to double by 1975. Within the chemical industry, the growth of synthetic organic chemicals has been most phenomenal.

The following table illustrates some of this growth.

Leaders in Synthetic Organic Chemical Growth*

(Production in Million Lbs.)

	1928	1938	1949	1958	1961
Plastics	20	130	1,486	4,518	6,709
Synthetic rubbers	0	5	1,173	2,202	2,807
Synthetic detergents and other surface-active agents	0	15	375	1,335	1,729
Nylon and other non-cellulosic fibers	0	0	66	489	889[1/]
Insecticides and other agricultural chemicals	0	8	27	530	608

*Source: The Chemical Industry Facts Bock, 1960-61 Edition

1/ Includes glass fibers in 1961

Synthetic dyes, adhesives, surface coatings, solvents, and many other industrial, agricultural, and commercial products have also registered substantial production growth.

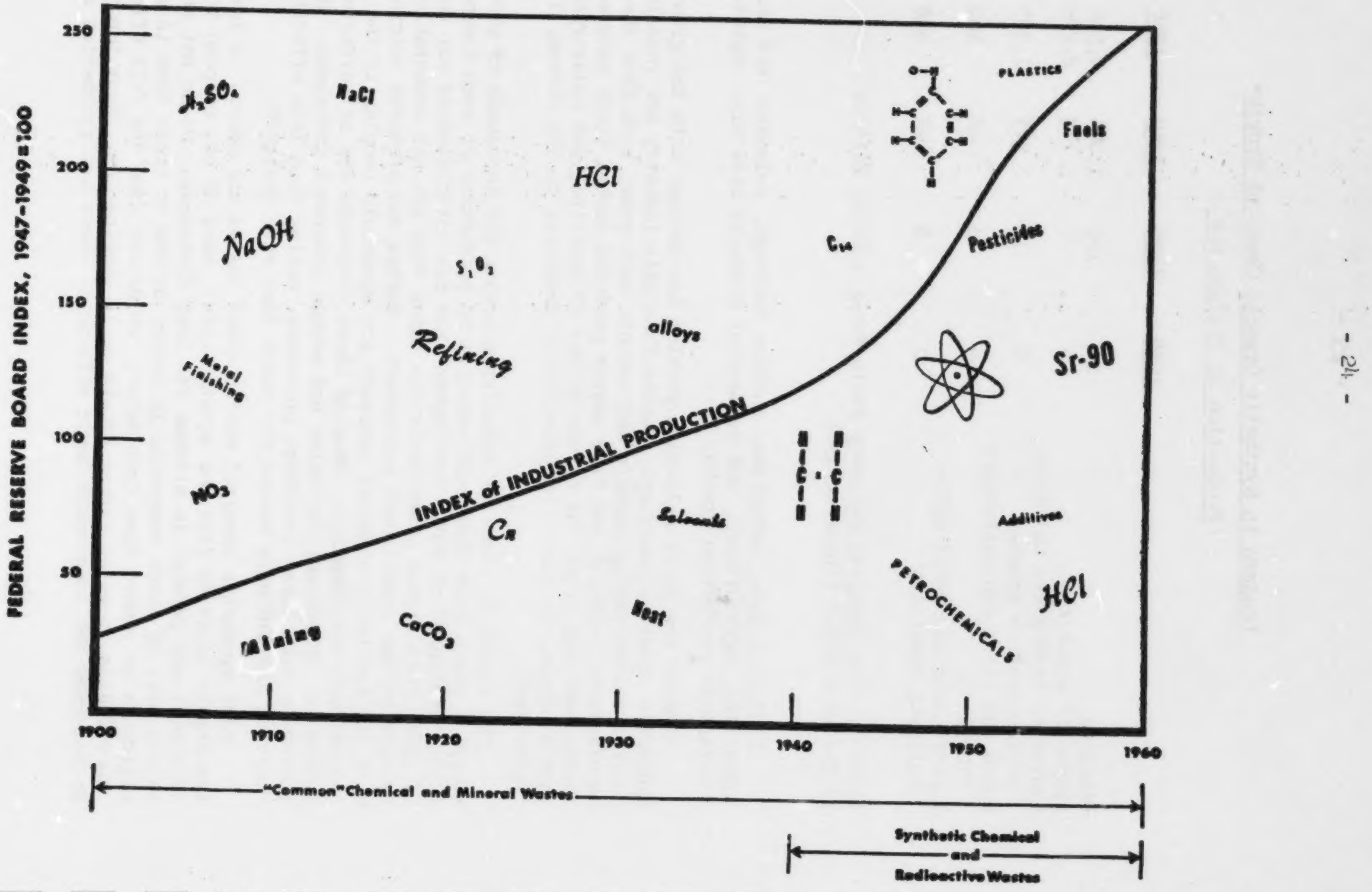
A major new water pollution problem has emerged with the growth of the synthetic chemical industry. Wastes from this industry are reaching watercourses in increasing numbers and amounts each year, both from the use of the manufactured products and from wastes produced during their manufacture. These chemicals reach the stream by way of municipal and industrial sewers, land drainage, or direct application of chemicals to the stream, lake or impoundment.

The synthetic chemical industry accounts for thousands of products today of which more than half were not in production or even dreamed of in 1940. The spped of their development has far out-distanced our knowledge of their pollutional characteristics since they are not measurable by most of the traditional parameters. Wastes and products originating with the synthetic chemical industry are extremely complex in their composition and behavior. Many of these compounds are not affected, or only partly so, by present-day water and sewage treatment processes. Some even interfere with these treatment processes, making them less effective in removing the ordinary wastes for which they were designed.

Some synthetic chemical wastes cause tastes and odors. A large number are highly toxic to fish and aquatic life. Many do not respond to biological treatment and persist in streams for long distances. We do not know how to detect most of these compounds in water, or how to treat them in waste effluents or remove them from water. We do not know the full effects of these wastes on water either singly or in combination. Most important we do not know the long-range toxic effects of these new synthetics on man.

INDUSTRIAL WASTES

A Problem of Increasing Production and Changing Technology



The new synthetic wastes are present in low concentrations in most waters for the moment but the industry is continuing its rapid growth. Each year we are finding increasing amounts of these wastes at our water supply intakes and since neither our sewage nor our water treatment plants remove them, they are reaching the consumer in increasing amounts. The extent of the synthetic waste problem is nationwide and it requires immediate attention.

The Control of Pollution from Municipal and Industrial Wastes

Treatment of Municipal Wastes - The only period during which sewage treatment works construction kept up with needs was during the Federal public works programs of the 1930's. Before that time and since, until very recently, the number of persons served by sewers increased much more rapidly than the number served by sewage treatment works. As a result, a large backlog of needed sewage treatment construction has accumulated through the years.

Very substantial progress in eliminating this backlog has been made since 1956 under the Federal construction grant program to assist municipalities in constructing needed treatment works, and under the 1962-63 Federal accelerated public works program. New construction needs resulting from population growth and obsolescence of older treatment works, however, offset a good share of this progress, requiring that a high level of municipal treatment plant construction be attained and maintained into the foreseeable future.

The estimated annual rate of investment in waste disposal facilties required to eliminate the backlog and provide for new construction needs within any given period is shown in the following table:

Required Annual Construction Rates
Municipal Waste Treatment Works
(in millions)

To Control Pollution by Year	Contract Costs (1963)	Associated Costs* (1963)	Total Cost (1963)	Projected Cost Index	Actual Cost Annual Average
1963	$2,086	$522	$2,608	109.3	$2,608
1964	1,219	305	1,524	112.3	1,545
1965	936	234	1,107	115.8	1,204
1966	797	199	996	119.3	1,040
1967	715	179	894	112.8	948
1968	663	166	829	126.3	892
1969	627	157	784	129.8	856
1970	600	151	751	133.3	832
1971	583	146	729	136.8	820

To Control Pollution by Year	Contract Costs (1963)	Associated Costs* (1963)	Total Cost (1963)	Projected Cost Index	Actual Cost Annual Average
1972	$ 569	$142	711	140.3	$ 811
1973	558	140	698	143.8	807
1974	550	138	688	147.3	806
1975	545	137	682	150.8	810
1976	542	136	678	154.3	816
1977	541	135	676	157.8	825
1978	541	135	676	161.3	836
1979	541	135	676	164.8	846
1980	542	136	678	168.3	860

* Includes engineering, legal, fiscal and administrative costs associated with construction.

Separation of Combined Sewers - Correction of the pollution problems caused by overflow from combined systems may be as varied as the circumstances in each community involved. In some cities, partial or complete separation may be required. In others, the best solution may be the construction of storage basins or treatment facilities at the point of overflow.

The separation of a combined sewer system into separate sanitary and storm sewer systems is a project of vast proportions, particularly in the densely populated areas of the older cities. Cost estimates of $214 million for the District of Columbia and $2¼ billion for Chicago have been reported. The minimum cost for the separation of all combined systems in the U. S. would probably be in excess of $8½ billion.

Alternative and less costly solutions in many cases might be to provide storage basins or treatment for overflows. In such systems, the excess flows would be taken off at the overflow structures and retained in storage basins for treatment at the municipal plant or at special treatment units designed for this purpose. In large and congested cities, the overflow outlets are likely to be located in areas which are too restricted or unavailable for storage or treatment installations and the transportation of overflow to available sites might be very costly. The feasibility of overflow treatment is, therefore, closely related to the cost and availability of sites for treatment facilities.

Treatment of Industrial Wastes - Although some segments of industry have made very commendable progress in the treatment of their wastes, a much larger segment has not met its responsibility for controlling the pollution it creates. The construction of needed industrial waste treatment facilities has never kept up with the increase in the number of waste outlets nor with the increase in production of wastes. As with municipalities, this has resulted in a large backlog of construction needs.

Information on industrial waste treatment construction needs is not nearly as complete for industries as it is for municipalities. However, data in the 1957 Inventory of Municipal and Industrial Waste Facilities, the 1958 Census of Manufacturers, and recent surveys by the Public Health Service indicate that more than 6,000 construction projects are needed for treatment of industrial wastes. It is estimated that the annual expenditures necessary to overcome this backlog and to keep pace with industrial growth will be at least equal to those required for the construction of municipal treatment works.

Where feasible, the discharge of industrial wastes to municipal sewer systems should be encouraged, provided that adequate measures for the treatment of municipal wastes are made available. This would provide for mixing of industrial wastes with sewage, making them more amendable to treatment, would make more effective use of trained treatment plant operators, and would provide for closer supervision over the efficiency of treatment provided.

Water Requirements for Dilution of Organic Waste Effluents - The total organic waste loads, including both municipal sewage and industrial wastes, are shown in the following table. The data show that a significant reduction in overall waste loads could be accomplished if a high degree of treatment can be provided, but that if the present rate of construction continues, there will be major increases in waste loads discharged by 1970.

Total Organic Waste Loads
Population Equivalents Discharged
1900-1980
(in millions)

Year	Municipal Sewage	Industrial Organic Wastes	Total Organic Wastes
1900	24.0	15.0	39.0
1920	40.0	49.0	89.0
1935	51.0	56.0	107.0
1950	60.0	100.0	160.0
1960	75.0	160.0	235.0
1970	78.0 1/	50.0 1/	128.0 1/
	85.0 2/	210.0 2/	295.0 2/
1980	70.0 1/	80.0 1/	150.0 1/
	114.0 2/	310.0 2/	324.0 2/

1/ Assumes that 80 percent removal of organic pollution by treatment will be obtained by 1980.

2/ Assumes that estimated present rate of construction will continue.

Even if reductions in overall waste loads are obtained, pollution problems will be intensified in many places because of the increasingly dense concentrations of population and industry in metropolitan areas. Such concentrations produce vast quantities of complex wastes which usually must be discharged into single and often relatively small watercourses. We can look forward to many serious pollution situations below these large centers of population and industry because the pollution load imposed by huge volumes of treated effluents will exceed the capacity of the receiving stream to assimilate these wastes.

Present methods of waste treatment can only remove a portion of the total polluting load. Thus, even where the best available treatment is provided, if the residual wastes are large in proportion to the assimilative capacity of the receiving stream, serious pollution problems will occur.

The situation at Chicago is a classic example of the profound economic, social, technical, and legal difficulties inherent in such a situation. Although Chicago provides secondary treatment for its wastes, the city pours into the Illinois waterway each day an effluent equivalent to the sewage from one million persons and containing solid wastes, suspended and in solution, amounting to 1,800 tons.

With the prospect of an increasing number of serious pollution situations below population and industrial complexes, even when the best treatment is provided, it will be necessary to provide increased dilution water at these places to control water quality. Even if goals of 80 percent removal of organic wastes are met nationally, large amounts of reservoir storage for the augmentation of stream flows will be required for controlling water quality and provide for water reuse.

The Senate Select Committee on National Water Resources in its recent nationwide study of water needs, estimated the amounts of reservoir storage for the augmentation of low stream flows that would be required, in addition to adequate waste treatment. The Select Committee found that it would be necessary to provide a total national augmented stream flow of 522 billion gallons per day by 1980 and 700 billion gallons per day by year 2000, in order to dilute the residual wastes being discharged after treatment. This latter requirement will require construction of 315 million acre feet of storage capacity at a cost of $12 billion by 1980, and an additional 127 acre feet at an additional cost of $6 billion by year 2000.

The recommended stream flows are based on the need to maintain a dissolved oxygen content throughout all streams of the nation of not less than four parts per million. The report also assumes the attainment by 1980 of 70 percent removal of organic pollutants by treatment of waste discharges, and 80 percent removal by the year 2000. The Select Committee's projections of pollution loads were based on median population growth projection prepared by Resources for the Future.

The Select Committee found that in order to provide these levels of waste removal, treatment works costing $42.4 billion would need to be constructed by 1980, with an additional $39.4 billion of such works by year 2000. The pollution data in the present report is based on the assumption that 80 percent removal of wastes should be accomplished by 1980. To meet this goal higher waste treatment expenditures would be required by 1980 but, in turn, the reservoir storage costs as computed by the Select Committee would be somewhat less. By the year 2000, however, the total of the costs would be the same as those estimated by the Select Committee.

The Select Committee's findings with respect to the need for stream flow augmentation were computed on the basis of organic waste loads. There are many other important factors which combine to make up the national pollution problem, including inorganic industrial wastes, and such factors as temperature increases, agricultural chemicals, and surface drainage, which will be described below. Many of these other problems will also benefit from stream flow augmentation. For example, if adequate stream flows are provided to assimilate treated organic wastes, in some cases inorganic industrial wastes will also be dilated sufficiently to make them innocuous.

Advanced Waste Treatment Research - It is clear that, in addition to achieving the necessary level of sewage treatment works construction, a major water pollution need is to develop new municipal waste treatment processes that will remove much more of the contaminants than is now possible. Large amounts of reservoir storage will be required because today's "complete treatment" methods will not be adequate in many instances to provide the necessary level of future waste removal requirements.

The development of advanced waste treatment methods which would reduce th the residual waste loads entering the Nation's streams would decrease the overall amount of water storage necessary to augment stream flows for the assimilation of treated organic wastes. This would permit use of scarce reservoir storage capacity for other purposes. At such future time as advanced waste treatment methods can be made available, reservoir storage assigned to low flow autmentation could be reallocated to other uses, such as water supply, power generation, recreation and irrigation.

What is accomplished by today's complete treatment? A fairly good job is done in removing oxygen-consuming materials, generally 75 to 90 percent. About the same amount is accomplished with respect to suspended materials, although in so doing another problem not yet satisfactorily solved is created; that is what should be done with the separated sludge? Some biological stabilization of the effluent is achieved by oxidizing nitrogen compounds to nitrates, only to create in a growing number of instances serious algae problems in downstream waters. A fraction of some of the dissolved organics is removed, such as synthetic detergents and other new commercial and industrial chemicals. This has been called "complete treatment," and the receiving stream has been relied on to complete the job.

What is it that present-day treatment methods do not remove? They do not remove 10 to 25 percent of the BOD nor but a fraction of the dissolved organic and mineral solids which normally account for 60 to 80 percent of all solids in municipal sewage. Present methods remove only a small amount of the new wastes entering sewerage systems in increasing numbers, varieties and amounts--detergents and other household chemicals, industrial chemicals of a wide variety, and industrial process wastes of a highly complex nature. Present methods do not remove the nutrients that support algal growths with consequent taste, odor, and nuisance problems.

Each water use adds increments of wastes that are not removed by biological treatment. If we are to meet water needs through repeated reuse, much more of the impurities must be removed from municipal wastes. To do this new treatment processes must be developed, probably based on entirely new concepts and principles, that will achieve what approaches conversion of waste waters to fresh waters. This is the objective of the Public Health Service's advanced waste treatment research program.

At present, known municipal waste treatment methods provide effective and economic means for the removal of the major part of the organic waste load. In all probability, the treatment plants of today will be utilized as basic units for the more advanced treatment methods of the future. Specialized treatment units designed to remove the residual pollutants may be added to the biological treatment plant of today in the same way that biological units are presently being added to primary treatment plants. Should new physical-chemical treatment processes of higher efficiency be developed through research, it may be possible in future designs to eliminate the biological processes in new treatment plant construction.

Industrial Waste Treatment Research - Fully effective methods have not yet been developed for the treatment of many organic and inorganic industrial wastes. A major need is research to develop satisfactory industrial waste treatment processes for those wastes where satisfactory treatment methods are not yet available, and to improve the effectiveness of existing methods. Application of the biological processes used in sewage treatment have been only partially successful with many organic industrial wastes. Chemical and physical methods have been used to remove both organic and inorganic industrial wastes with varying degrees of success. The wastes resulting from the manufacture and use of the new synthetic chemicals are extremely stable and respond only slightly to conventional water and waste treatment methods. Research on in-plant process changes and more effective by-product recovery may provide means of preventing these wastes from reaching hazardous levels in our streams.

The advanced waste treatment research project of the Public Health Service should also assist in the solution of a number of industrial waste problems. Although this research is directed specifically to the treatment of municipal wastes, the findings should be applicable to the treatment of many industrial wastes as well.

The Extent and Control of other Pollutants

Radioactive Wastes - A new water pollution problem of serious potential has emerged in recent years from the growth of nuclear technology. The presence of radioactive materials in our streams is adding another new contaminant to the Nation's water supply that has serious health implications if not controlled. controlled. Much concern has been expressed over radioactive water pollution and two Federal water pollution control enforcement action by the U. S. Public Health Service have already dealt with this problem. Data provided by the Service's National Water Quality Network show that radioactivity in the Nation's lakes and streams is well below the safe allowable concentration. Nevertheless, radioactive water pollution must be rigidly controlled in light of total exposure in the human environment.

Radioactive substances which are possible sources of water pollution are produced from several activities. Pollution by radioactive materials from nuclear weapons testing is well-known. Waste products from mining and refining radioactive minerals, such as uranium or thorium, may wash or be discharged into streams. Waste products from refined radioactive substances used in power reactors or for industrial, medical, or research purposes require adequate control measures to prevent dangerous concentrations from escaping to streams.

Radioactive materials are characteristic of a newly developing class of water pollutants that are subtle in effects and not detected by the usual stream pollution analyses. Even so, their control is a problem in principle no different than the control of the more common types of wastes from other industries. Conventional water and waste treatment plants in use today are not designed to provide protection against these hazardous materials. While some protection is afforded by existing water treatment processes, it is not likely that they can be easily or economically modified to provide full protection. It appears that the only practical means of protection against excessive human exposure to radioactive wastes in water will be treatment and control of such wastes at their source. This will require constant vigilance and effective preventive measures.

Heat - Heat pollution is becoming an increasing matter of concern to water pollution control administrators and to the conservationists. Heat pollution from both industrial and power plant sources can be expected to increase at a very substantial rate on the basis of projected industrial growth and electric power demands. Industrial production is expected in 1970 to be some 40 percent higher than present figures. Since 1900, electric power production has approximately doubled every 10 years and is expected to double again by 1970. Unless controls are affected, this could mean an increase in heat pollution of more than 100 percent in the next 10 years. This does not even take into account the increase in water temperatures that will accompany the increase in impoundments for hydropower, irrigation, navigation, flood control and water supply purposes.

In areas of population and industrial concentration, such an increase in heat pollution in lakes and streams could have a profound effect on the ability of the waters to assimilate even well-treated wastes, or to serve increasing demands for recreational and fishing opportunities.

Two examples will illustrate the potential of heat as a pollutant. Extensive use of the Mahoning River in Ohio for industrial and power cooling purposes raises the summer temperature of the water to such an extent that fish life is completely eliminated, and the river has no capacity for pollution assimilation or for additional cooling. In the Illinois River near Chicago, the effect of thermal pollution from steam-electric plants is reported to result in the equivalent of doubling the organic waste load from the Chicago area, i.e., from the present population equivalent of more than one million to more than two million.

The heat pollution problem can be effectively reduced by careful planning in the location of heat-producing plants, the use of control measures such as recirculation, cooling towers and spray ponds, and by the substitution of air cooling methods wherever practicable. Reduction of water temperatures will also play an increasing role in programs of streamflow regulation for water quality control. This will require making adequate provisions in the design and operation of reservoir systems for the release of cooler water from the lower levels of reservoirs.

Land Drainage Wastes - In the past, land drainage wastes were not usually considered a primary concern of water pollution control agencies. In recent years, however, it has been recognized that land drainage is having an increasingly important effect on water quality, and it is receiving increasing attention from the standpoint of pollution control.

Most pollutants can be traced to a point source along the stream. Contaminants resulting from land drainage, however, may have their source in an entire watershed. By the nature of this pollution it cannot be collected and treated as can be done with wastes from cities and industries.

Land drainage pollutants present a variety of problems, and a wide variety of solutions will have to be developed to deal with them. These will range from improvements in land use practices to industrial process changes to reduce the polluting effects of products which are applied to the land.

Silt - Sediment loads result from soil erosion, and are of major magnitude in many river basins. Two examples will illustrate the magnitude of silt loadings. It has been estimated that the annual silt carried by the Potomac River amounts to as much as 40 million cubic feet. The Corps of Engineers have estimated the sediment load in the Mississippi Basin above the delta to be about 500 million tons per year.

With rapid population growth and shift of population to the "suburbia" of urban areas there has been created a "new" siltation problem. In the interests of production costs, housing developers have moved into suburban areas with bulldozers and completely denuded large areas of land of all vegetative cover. During the construction periods, which often last from a few months into years, the raw land is exposed to severe erosion with resulting heavy silt pollution of streams. Serious local pollution problems are resulting from such practices in many parts of the country and with a readily identifiable offender, pollution control agencies are turning their attention to them. The recent increase in highway construction creates much the same problem and has become a major source of silt pollution.

Brush and Forest Fires - With the increasing need for water, particularly in water-short areas, brush and forest fires are a matter of serious concern in some areas, such as Southern California. Fire destroys the vegetative land cover, increasing erosion and stream siltation, causing rapid runoff of needed waters, and creating tastes and odors from leaching of burned materials. The practice of burning off agricultural and grass lands has been reported as causing local pollution problems.

Irrigation Return Flows - Irrigation return flows have been a major water pollution in the 17 Western states for many years and have increased as more land has been put under irrigation. As irrigation waters percolate through the soil they dissolve important amounts of minerals and other substances. The same waters are used over and over with the result that there are repeated additions of minerals. Evaporation losses are high and this further adds to the concentration of pollutants. In many instances, irrigation return flows render streams unfit for further use, including irrigation, until some dilution of their mineral content is provided. With competition for use of the available water increasing in the Western states, the protection of water quality from deterioration resulting from irrigation return flows will assume growing importance.

Widespread supplemental irrigation practice in the humid eastern States would have a profound effect on both water quantity and quality. However, predictions made to the Senate Select Committee on National Water Resources did not foresee this development, predicting about a 30 percent increase in water use for supplemental irrigation between 1957 and 1980. In specialized farming areas, however, it may prove to be a problem.

Urban Land Drainage - Another and increasing problem of land drainage water pollution is resulting from urban population and economic growth. Each year additional millions of acres of land are withdrawn for use for streets, highways, airports, housing and other buildings. The runoff from these hard-surfaced areas is nearly 100 percent and with it all of the accumulated deposits--oils, organic matter, trash, soil and industrial dusts, other air pollutants, fertilizers and pesticides used by weekend horticulturists, and whatever else can be hydraulically washed into a catch basin or nearby stream. In addition, municipalities with combined sewers are by-passing increasing amounts of storm water sewage as hard-surfaced areas and populations are increased. Only recently have pollution control agencies looked into the matter of urban land drainage and have found found its pollution potential to be highly significant. Much study of this important and growing problem is needed.

Agricultural Pesticides - Perhaps the most important and emerging land drainage problem involves the tremendous increase in the use of agricultural pesticides and fertilizers. Pesticides include those chemicals designed for use as insecticides, herbicides, fungicides, rodenticides, miticides, nematocides, fumigants, defoliants, plant growth hormones, and soil conditioners. The insecticides, herbicides and fungicides in that order account for well over 90 percent of all present synthetic pesticide production. Fertilizers consist primarily of various compounds and formulations of nitrogen and phosphates, both natural and synthetic. Lime is used in large quantity, usually in the form of quicklime, hydrated lime and ground limestone.

Over 45,000 pesticide formulations are registered for sale with the U. S. Department of Agriculture. The new synthetics are rapidly replacing the older inorganic insecticides (arsenicals, copper and zinc sulfate, sodium chlorate, boron, and sulfur). Production of synthetic pesticides and other agricultural chemicals in 1961 amounted to nearly 700 million pounds and most of this production was used by U. S. farmers. Each new pesticide introduced on the market is generally more toxic than its predecessor.

More than 30 million acres of cultivated cropland are sprayed one or more times annually in the United States. Aerial spraying is increasing. The treatment of pasture lands and non-croplands, such as highway rights-of-way, is adding to the total use of herbicides and other pesticides. Also, the chemical control of rough fish, aquatic vegetation, and nuisance plants such as mesquite is increasing. Urban dwellers account for a small but significant share of the growing pesticide market.

This greatly expanded use of synthetic organic pesticides has occurred mainly since the development of DDT in 1942, and is creating new problems of water pollution. With some 500 million pounds of highly toxic chemicals being broadcast over the land it is inevitable that some of it will reach our watercourses. They may be applied directly to the water, they may drift into water during the treatment of adjacent areas, or they may be washed in from treated areas of the entire watershed. Many of these materials have a long residual toxicity in the soil. Numerous fish kills have been traced to pesticides. In other situations aquatic life, both animal and vegetable, making up the food chain of fishes has been wiped out.

U. S. Fish and Wildlife Service experiments with various insecticides to determine toxicity to fish and small game indicate that there may be insidious consequences in small mammal and birds from prolonged exposure to small quantities of insecticides. Observations on quail indicated that a large percent of the eggs were infertile and chicks were often weak, resulting in a decimation of population. In the water environment the insecticide seemed even more destructive.

Analysis of samples taken in connection with several Public Health Service investigations and the National Water Quality Basic Data Network program has shown the presence of pesticides in most of our major rivers. For example, DDT has been found in Lake St. Clair, the Detroit River, the Mississippi at Quincy, Illinois, and at New Orleans, in the Missouri River at Kansas City, and in the Columbia at Bonneville Dam.

Most pesticides are removed only in part by ordinary water treatment processes. While the concentrations found thus far have no apparent significance from the standpoint of acute toxicity to humans as drinking water contaminants, they are approaching levels which may be toxic to fish under continuous exposure. Although there are no recorded incidents of acute toxic effects on humans through water supplies, some pesticides have sufficient toxicity. As the use of these chemicals increases, chronic effects of their long-term ingestion may well be of greater significance than acute toxicity.

As a result of Public Health Service studies and those of others, it is believed that the trend for more toxic and broad spectrum pesticides must be reversed towards development of more specific ones. There must be a concentration on control through careful application if more serious pollution problems are to be avoided. These studies indicate that we should concern ourselves immediately and more intensively with the trends and effects of pesticides in water.

In 1958 industry spent a reported $305 million for organic chemical research. A good share of this went for studies to determine compliance with regulations for the safety of foods of the U. S. Department of Agriculture and the Food and Drug Administration. It seems that another fair share should be directed towards determining the effects of these chemicals as water pollutants. Some indication of the magnitude of the pesticide problem in the immediate years ahead has been given by Mr. Wayne R. Yoder, manager of American Cyanamid's pesticides products department. In the March 27, 1961, issue of Chemical and Engineering News he predicted a 10-fold increase in pesticide output in the next 20 years. This could mean in 1980, pesticide production amounting to more than 5 billion pounds annually.

Agricultural Fertilizers - As it has become necessary to feed more and more people, and as scientific farming has progressed, the U. S. Farmer is using more and more chemical fertilizers. The growth of fertilizer tonnage and nutrient content is shown by the following figures:

GROWTH IN U. S. FERTILIZER AND NUTRIENT CONTENT

YEAR	TONNAGE (in thousands)	PLANT-FOOD CONTENT (%)
1935	6,345	18.2
1945	13,201	20.0
1950	17,978	22.0
1952	22,052	23.1
1954	22,362	25.8
1956 (Preliminary)	21,697	27.5

* All years after 1935 are fiscal years ending June 30.
Source: USDA, Agricultural Research Service.

Production of synthetic fertilizers has also increased sharply from 790,000 tons of plant food in 1925 to 4,430,000 tons in 1950. Liquid fertilizers are also increasing in production and use, rising from about 40,000 tons in 1946-1947 to about 710,000 tons in 1954-1955. Lime is another agricultural chemical used in large quantity, estimated to average about 20 to 25 million tons annually and 3 times this amount is reported to be needed to maintain soil fertility and crop yield efficiency.

The use of agricultural fertilizers will undoubtedly continue its growth as new lands are put into use and as more intensive farming practices become profitable. For example, "tree farming" may prove to be a significant market since each year a million acres of tree farms are being planted.

Fertilizers applied to agricultural lands find their way into natural waters principally during surface run-off and from soil leachings. Their significant pollutional effect thus far appears to be the adding of nutrients to the water environment although as their use increases there may be other effects, such as increased hardness and mineralization.

These added nutrients are capable of, and often do, support heavy aquatic growths--bacterial, algal, vegetation, and others--particularly in impoundments. Many of these forms of aquatic growths improve the fishing environment but usually this proves to be a more serious detriment than benefit because such growths often cause serious tastes and odors in water supplies that are difficult and expensive to remove. Such growths, particularly in impounded waters and in highly-regulated streams, frequently cause serious local nuisances to sight and smell that also adversely affect the value of recreational waters. In some commercial fishing waters (viz., the Columbia River) filamentous growths foul nets and create other nuisance conditions.

Stream pollution from agricultural fertilizers, supplemented by the increasing amounts of nutrients from municipal and industrial wastes, is becoming a water pollution problem that may reach national significance. A widespread increase in the growth of nuisance organisms and plants would have serious degrading effects on water quality and use. Any substantial increase in nitrates in water will certainly have medical epidemiological interest since excessive ingestion of nitrates is known to cause infant methemoglobinemia ("blue babies").

Control of water pollution by fertilizers is difficult, and like the control of agricultural pesticides, can probably best be done by control of applications. We need to know a good deal more about this increasing water pollution problem--its full effects, the trends, and how it can best be controlled.

Nonwithdrawal Water Uses - Two nonwithdrawal water uses result in significant water pollution--navigation and recreation. Less widespread but often significant where it occurs is pollution from logging operations in water transport of logs to mills.

Recreation - Recreational use of waters--swimming, water skiing and boating--can cause measurable pollution. The pollution resulting from water contact sports is principally bacterial. Although epidemiological studies have been made, some of considerable duration and scope, the extent of infections traceable to recreational use of waters is not fully known. It has been demonstrated epidemiologically, however, that such infections can occur.

The very large increase in recreational boating and water skiing is resulting in increased pollution. Most recreational craft do not have waste disposal facilities and galley and toilet wastes are discharged directly into the water. Also, many boat owners are "litterbugs" on the water as well as on the highway. These kinds of pollution create particular problems when recreational watercraft are clustered together in anchorages, both in fresh waters and coastal salt waters. The problem is widespread and many States are developing and enforcing regulations to deal with it.

A new and perhaps serious problem of pollution is resulting from the growth of outboard motor boating and water skiing, particularly on lakes and reservoirs. Public Health Service studies are showing that significant concentrations in such waters of oil, lead and combusion products from outboard motor exhausts is possible. Combusion products include carbon monoxide, phenols, benzpyrenes and other substances in air pollution. Motorboat exhaust wastes have been shown to cause tastes and odors, taint fish flesh, and in sufficient concentration are toxic to fish and aquatic life. The toxic significance of lead and hydrocarbons imported to recreational waters by boat motors is being studied. The continued increase predicted for motorboating and water skiing indicates that serious attention should be given to the exhaust problem.

Navigation - Navigation is an old and continuing source of water pollution in estuaries, harbors and coastal waters. With the opening of the St. Lawrence Seaway, it is a growing problem in the Great Lakes that is creating concern. Ship pollution consists of bilge waters, sanitary sewage, garbage (including cargo spoilage), oils and whatever can be thrown overboard. Accidental spills in pumping liquid cargoes to shore occasionally cause serious problems as do navigation accidents.

Few ships afloat today, even those of recent design, have any facilities for the collection, treatment or disposal of shipboard wastes. Laws and harbor regulations are very difficult to enforce. Bilges can be pumped out at night and many ship's captains do not honor the 10-mile limit in this regard. Accidents and carelessness in handling cargoes can happen at any time. Anyone who has ever visited a harbor waterfront has appreciation of the effects of ship pollution, although it must be said that, in many instances, pollution from municipal sewers and streets is the major offender.

The St. Lawrence Seaway has opened the Great Lakes to 90 percent of the world's commercial vessels. Most of the larger cities fronting on the Great Lakes are planning extensive harbor facilities to attract the anticipated increase in shipping. The increase in vessel pollution which may accompany this increase in shipping is a matter of considerable concern in the Great Lakes, involving water supplies, recreational beaches and real estate values. Some statistics may point up the expansion of this problem. In 1958, prior to the opening of the Seaway, 130 vessels were plying the Great Lakes. In 1959, the first year the Seaway was opened, the number of vessels rose to 420, and to an estimated 600 in 1960. Cargo tonnage has materially increased, rising from 87,000 tons at Detroit in 1958 to 264,000 tons in 1959. Other Lake ports showed even greater increase as at Duluth-Superior where tonnages rose from 21,400 tons in 1958 to 1,620,000 tons in 1959.

The discharge of shipboard sewage near public water supply intakes is of special concern since many of these intakes are in or near present port areas or those being planned for development. With ships from all parts of the world entering and harboring in waters adjacent to public water supply intakes, the chances are greatly enhanced for waterborne disease transmission, and particularly those diseases from other countries which have long been gone from the American scene or never have gotten a foothold here. Ships taking on fresh water from the Great Lakes run the same risk, particularly if by chance they are in the same lane with other ships that are discharging or have discharged sewage.

In addition to cargo traffic, passenger traffic is also being developed, and this year two vessels with accommodations for 115 passengers each went into Great Lakes service. At least 30 others have accommodations for 5 to 65 passengers. With practically no promotion, 492 passengers arrived on overseas vessels in 1960. Ships crews range in number from 16 to 57, averaging 32, and crew populations aboard ships in 1960 totalled nearly 20,000.

In 1961 there were 38 lake carriers and six maritime vessels that had some kind of shipboard waste control device. In contrast, 562 lake carriers, two passenger ships, and an undetermined number of auto ferries and maritime vessels discharged raw wastes directly to the Lakes.

Incineration is the only presently satisfactory method of disposing of garbage and in 1960 only 12 U. S. and five Canadian ports were approvable for discharge of garbage from overseas vessels. The magnitude of the garbage problem is indicated by a U. S. D. A. Plant Qurantine Division survey of 170 vessels in 1960, which showed that an average of 15 bushels of garbage per ship were accumulated between ports. A rough calculation shows that between 1,000 and 2,000 tons of garbage were generated aboard overseas vessels in 1960 while in the Great Lakes.

The full extent of vessel pollution in the Great Lakes has not been measured but a study to do this will be a part of the development of a comprehensive water pollution control for the Great Lakes now underway by the Public Health Service in cooperation with the Lake States and other Federal agencies.

ECONOMICS OF WATER POLLUTION

Almost every one agrees that the Nation and its communities, as well as business and other private operations and individuals, incur losses or damages because of water pollution. Some of these losses or damages are reflected directly in additional costs which must be met, such as the payments for the construction, operation, and maintenance of water treatment facilities. By far the larger share of the total damages is not directly accounted for at all, however. The impairment to health, the loss or diminution of recreational uses, and depreciated property values, all caused by polluted waters, have an adverse economic impact which is diffused throughout society. This is paid for through the reduction in utility of the water resource and the restriction on economic growth rather than through dollar payments for corrective devices. Unfortunately, these latter indirect consequences of pollution are not readily expressed in dollar terms because of their diffusiveness and because they are not recorded overtly in market transactions. Nevertheless, such adverse consequences are real and constitute a handicap to the fulfillment of economic and social goals.

Pollution control measures alleviate these adverse conditions and produce economic benefits associated with the improved waters. These benefits are often not apparent to the public, however, because they constitute insurance for future usefulness as well as for immediate purposes. The computation of these benefits faces the same difficulties as the computation of the total damages. That is, the dollar measurement problem has not yet been solved and a yardstick for actions or events not recorded in market transactions is lacking. Many of the benefits from pollution control are in this non-market realm, i.e., enhancement of recreational opportunity, protection to health, scenic improvement, and assurance of future utility of the water resource. The private market price system, therefore, cannot be relied upon solely or chiefly to provide the measurement. New devices taking into account the social or public values will need to be constructed. These devices will enable definite answers to be obtained for such important questions as:

1. What does water pollution cost a community, a region, or the Nation in damages from all consequences?

2. What are the specific benefits from alleviation of these damages and what is their economic worth?

3. Who will benefit from the controlled pollution and to what extent?

4. How much can be justifiably spent in controlling a pollution situation?

5. How should the costs of control be apportioned among the members of the community, the region, and the Nation?

Obviously, answers to these questions are essential for sound planning of water resources programs. Still, the objective will not be attained just because these measurement obstacles are overcome. A major hindrance to achievement is the apparent reluctance of the public to finance the programs of pollution control. Much of this reluctance is attributable to the lack of identification between tax payments and the pollution control services or functions provided by government. Much of the expenditures on pollution control measures are paid for through general taxation,and the taxpayer is not likely to see a close connection between his tax payments and benefits resulting from cleaner waters. On the other hand, payments made to private operators for goods and services such as food and medical care, are usually made directly by the purchaser to the supplier with the result that the need and purpose of the payments is immediately apparent to the payer. Thus, the private realm has the advantage of more tangible, overt transactions made by the individual purchaser on a voluntary basis. The lump-sum nature of the payments made to government for services and functions are equally as essential to well-being as those obtained from the private realm but suffers because they are compulsory, indirect payments. Students of government and public finance must improve considerably the psychology of governmental expenditure so that the public will gain appreciation of the nature and necessity of the system. Pollution control, as well as other programs, will then be in a much improved position to protect and further the public interest.

The application of basic economics is needed to develop valid yardsticks by which reliable dollar measurements can be made of the costs of water pollution and benefits from its control. With such data, water resources can be accomplished on a more sound economic basis. Achievement of this goal will require measurements for the value of each water use. These may well differ according to the region or situation involved.

Because of the magnitudes of investments required to achieve water quality control and because of the extensive ramifications throughout the economy of polluted waters, more economists are scrutinizing the situation. The increased attention acts as a stimulus to technical experts already involved and to scholars, public administrators, and others. It is imperative that the intensity of this pace be increased, for adverse economic effect on human welfare is too great for correction to be left to chance or the sporadic attention of the general public.

RESPONSIBILITY IN THE NATIONAL WATER POLLUTION CONTROL PROGRAM

Being a national problem, water supply and pollution control generates the need for action at all levels, resulting in a five-way sharing of responsibility. In broad terms, these responsibilities are defined as follows:

The State has primary responsibility for water pollution control. It sets the standards in its jurisdiction, and applies its laws and regulations, including intrastate enforcement. It conducts surveys and investigations, collects and analyzes data, provides technical assistance to local governments and industry including training, and does research, largely developmental.

Local Governments construct and operate municipal sewage treatment works, conduct surveys, provide technical assistance and consultation to industries, and enforce their regulations and ordinances.

Industries are responsible for their own pollution. They institute inplant waste reductions, and construct and operate waste treatment works if separate from municipalities. Industries make alterations in the plant or adopt new processes to reduce or eliminate pollutants. They conduct research to develop or improve waste treatment processes, and to reduce waste production.

Universities are responsible for conducting research and for training engineering and scientific manpower needed by the other jurisdictions. They also provide technical services and consultation.

The Federal Government has a leadership role to play in water pollution control. It supplements and supports the programs of the other four. It conducts research and investigations, collects and analyzes data on a nationwide basis, and provides technical assistance to State and local governments and industries, including training. It develops comprehensive water supply and pollution control programs and coordinates these with the States and with the water resources programs of other Federal agencies. It carries out the enforcement provisions of the Federal Water Pollution Control Act. It provides grants for State program development and incentives to municipalities for construction of sewage treatment works, and for research, demonstrations and training.

FEDERAL LEGISLATIVE HISTORY

Statutory definition of the Federal role and responsibility in water pollution control has evolved over a sixty-year span. During this period, more than a hundred bills to establish a Federal pollution control program were introduced, none of which became law. Until the enactment of the Water Pollution Control Act of 1948, the only Federal role in water pollution was contained in three Acts -- the Rivers and Harbors Act of 1899, the Public Health Service Act of 1912, and the Oil Pollution Act of 1924.

A section of the Rivers and Harbors Act of 1899 (33 U.S.C. 407) prohibited the discharge or deposit into any navigable waters of any refuse matter except that which flowed in a liquid state from streets and sewers. This provision, designed primarily to prevent impediments to navigation, constituted the first specific Federal water pollution control legislation. Human health factors in water pollution received attention in the Public Health Service Act of 1912 which contained provisions authorizing investigations of water pollution related to the diseases and impairments of man. The Oil Pollution Act of 1924 was enacted to control oil discharges in coastal waters damaging to aquatic life, harbors and docks, and recreational facilities.

Efforts to obtain comprehensive Federal water pollution control legislation continued, however, and were almost successful on three separate occasions in 1936, 1938, and 1940. These efforts were interrupted by World War II but were renewed in 1947, and culminated in the enactment by the 80th Congress of the Water Pollution Control Act of 1948 (P.L. 845-80th Congress). This law was admittedly experimental and initially limited to a trial period of five years, after which it was to be reviewed and revised on the basis of experience. This five-year period was extended for an additional three years to June 30, 1956, by P.L. 579-82nd Congress.

THE FEDERAL WATER POLLUTION CONTROL ACT

Comprehensive water pollution control legislation of a permanent nature was enacted by the 84th Congress with the passage and approval on July 9, 1956, of the Federal Water Pollution Control Act, Public Law 660-84th Congress. The 1956 Act extended and strengthened the 1948 law, which expired on June 30, 1956.

The Federal Water Pollution Control Act, administered by the Surgeon General of the Public Health Service under the supervision and direction of the Secretary of Health, Education, and Welfare:

1. Reaffirmed the policy of Congress to recognize, preserve, and protect the primary responsibilities and rights of the States in preventing and controlling water pollution;

2. Authorized continued Federal-State cooperation in the development of comprehensive programs for the control of water pollution;

3. Authorized increased technical assistance to States and intensified and broadened research by using the research potential of universities and other institutions outside of Government;

4. Authorized collection and dissemination of basic data on water quality relating to water pollution prevention and control;

5. Directed the Surgeon General to continue to encourage interstate compact and uniform State laws;

6. Authorized grants to States and interstate agencies up to $3,000,000 a year for the next 5 years for water pollution control activities;

7. Authorized Federal grants of $50,000,000 a year (up to an aggregate of $500,000,000) for the construction of municipal sewage treatment works, the amount for any one project not to exceed 30 percent of cost or $250,000, whichever is smaller;

8. Modified and simplified procedures governing Federal abatement actions against interstate pollution;

9. Authorized the appointment of a Water Pollution Control Advisory Board; and

10. Authorized a cooperative program to control pollution from Federal installations.

FEDERAL WATER POLLUTION CONTROL ACT AMENDMENTS OF 1961

Proposals to amend the Federal Water Pollution Control Act to provide for a more effective program of water pollution control were introduced early in the 1st session of the 87th Congress and received the endorsement of President Kennedy in his Message on Natural Resources of February 23, 1961. The Congress enacted and President Kennedy signed into law the Federal Water Pollution Control Act Amendments of 1961, Public Law 87-88, on July 20, 1961. The 1961 Amendments improved and strengthened the Act by:

1. Extending Federal authority to enforce abatement of intrastate as well as interstate pollution of interstate or navigable waters and strengthening enforcement procedures;

2. Increasing the authorized annual $50 million Federal financial assistance to municipalities for construction of waste treatment works to $80 million in 1962, $90 million in 1963, and $100 million for each of the four following fiscal years 1964-1967; raising the single grant limitation from $250,000 to $600,000; and providing for grants to communities combining in a joint project up to a limit of $2,400,000;
3. Intensifying research toward more effective methods of pollution control; authorizing for this purpose annual appropriations of $5 million up to an aggregate of $25 million and authorizing the establishment of field laboratory and research facilities in, among others, seven specified major areas of the Nation;
4. Extending for seven years until June 30, 1968 and increasing Federal financial support of State and interstate water pollution control programs by raising the annual appropriation authorization from $3 million to $5 million;
5. Authorizing the inclusion of storage for regulating streamflow for the purpose of water quality control in the survey or planning of Federal reservoirs and impoundments; and
6. Designating the Secretary of Health, Education, and Welfare to administer the Act.

SCOPE OF FEDERAL PROGRAM

Four major points need to be considered in reviewing the broad scope of the program contained in the Federal Water Pollution Control Act as amended

1. The Act makes it clear that there is to be a strong Federal role in water pollution control;
2. The provisions of the Act make it mandatory that the Secretary carry out certain of the specified programs;
3. The Act provides for broad water quality control responsibilities for all water uses; and
4. The Act assigns to the Department the primary Federal responsibilities for water pollution control and in so doing, assigns it the role of a major Federal water resources agency.

The Federal Water Pollution Control Act goes beyond the usual public health legislation in that it assigns to the Department the responsibility for controlling water pollution to conserve and improve water for all use propagation of fish and aquatic life and wildlife, recreation purposes, industrial and agricultural (including irrigation) supplies, and other legitimate purposes, as well as public water supplies and protection of the public health.

Legislated Responsibilities

The programs authorized and directed to be carried out by the Act provide a broad base for dealing with both the water resources and the health aspects of water pollution prevention and contol. Specifically, the Secretary is:

1. Directed to encourage cooperative activities by the States in:
    a. the prevention and control of interstate pollution;
    b. the enactment of improved laws to control water pollution; and
    c. the establishment of interstate compacts.
2. Authorized to make grants to State and interstate agencies to assist them in meeting costs of water pollution control programs ($5 million annually through Fiscal Year 1968).
3. Authorized to make grants to municipalities for the construction of waste treatment works ($80 million in Fiscal Year 1962, $90 million in 1963, and $100 million annually thereafter through Fiscal Year 1967. Individual grants limited to 30 percent of cost of project or $600,000, whichever is smaller; where project will serve more than one municipality, the total of such grants is limited to $2.4 million).
4. Authorized to make grants-in-aid to public and private agencies and institutions and to individuals for the conduct of research or training projects and for demonstrations, and to contract for such activities.
5. Authorized to establish and maintain research fellowships.
6. Authorized to provide technical training to personnel of public agencies and other qualified persons.
7. Authorized to provide technical assistance to any State water pollution control agency or interstate agency, community or industrial plant.
8. Directed to develop comprehensive river basin programs for the prevention and control of water pollution, in cooperation with the other Federal agencies, State and interstate water pollution control agencies, municipalities and industries involved.
9. Directed to determine the need and value of storage in any Federal reservoir for flow regulation for the purpose of water quality control, and make recommendations thereto.

10. Directed to institute Federal enforcement action for the control of pollution of interstate or navigable waters endangering the health or welfare of any persons whenever requested by the Governor of any State or a State water pollution control agency, or (with the concurrence of the Governor and the State agency) the governing body of any municipality; or when he has reason to believe that pollution originating in one State is endangering the health or welfare of persons in another State.

11. Directed to conduct a broad program of research, experiments, investigations, demonstrations and studies relating to the causes and control of water pollution; and specifically to develop and demonstrate: (a) practicable means of removing the maximum possible amounts of pollutants from sewage and other waterborne wastes; (b) improved methods and procedures for identifying and measuring the effects of pollutants on water uses; and (c) methods and procedures for evaluating the effects on water quality and uses of augmented streamflows to control water pollution not susceptible to other means of abatement ($5 million annually up to an aggregate of $25 million authorized for these three areas of research).

12. Directed to collect and disseminate basic data on chemical, physical and biological water quality and other information relating to water pollution prevention and control.

13. Directed to establish, equip, and maintain field laboratory and research facilities, including but not limited to locations in the Northeast, Middle Atlantic, Southeast, Midwest, Southwest, Pacific Northwest, and Alaska, for the conduct of research, investigations, experiments, field demonstrations and studies, and training relating to pollution control.

14. Directed to conduct research and technical development work and studies with respect to present and future water quality of the Great Lakes and means of solving water pollution problems.

Further, the Act authorizes:

1. The establishment of a Water Pollution Control Advisory Board appointed by the President to advise, consult with and make recommendations to the Secretary on matters of policy relating to his activities and functions under the Act; and

2. A cooperative program to control pollution from Federal installations.

Additional Responsibilities

Technical Services - In addition to its legislated programs, the Department has the responsibility of providing specialized technical services to other

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Federal agencies relating to water supply and pollution control. These stem from the Department's membership on the Interagency Committee on Water Resources, its Agreements with other Federal agencies, services required by International Commissions, and special needs of States and regional jurisdictions.

Water Supply Act of 1958 - Enacted as Title III of the Rivers and Harbors Act of 1958, the Water Supply Act of 1958 provides that storage may be included in any reservoir project undertaken by the Corps of Engineers or the Bureau of Reclamation for present or anticipated future demand or need for municipal or industrial water. The Act specifies the manner in which costs of such water supplies shall be reimbursed and makes provision for deferral of repayment of not to exceed 30 percent of the total estimated cost of any project allocated to anticipated future demands.

In accordance with a mutually cooperative agreement entered into with the Department of the Army, the Department of Health, Education, and Welfare reviews Corps of Engineers projects and provides determinations of future water storage requirements for municipalities and industries over a period of 50 years, together with the economic value of such water supplies.

Similar studies are conducted in connection with Bureau of Reclamation projects in some regions.

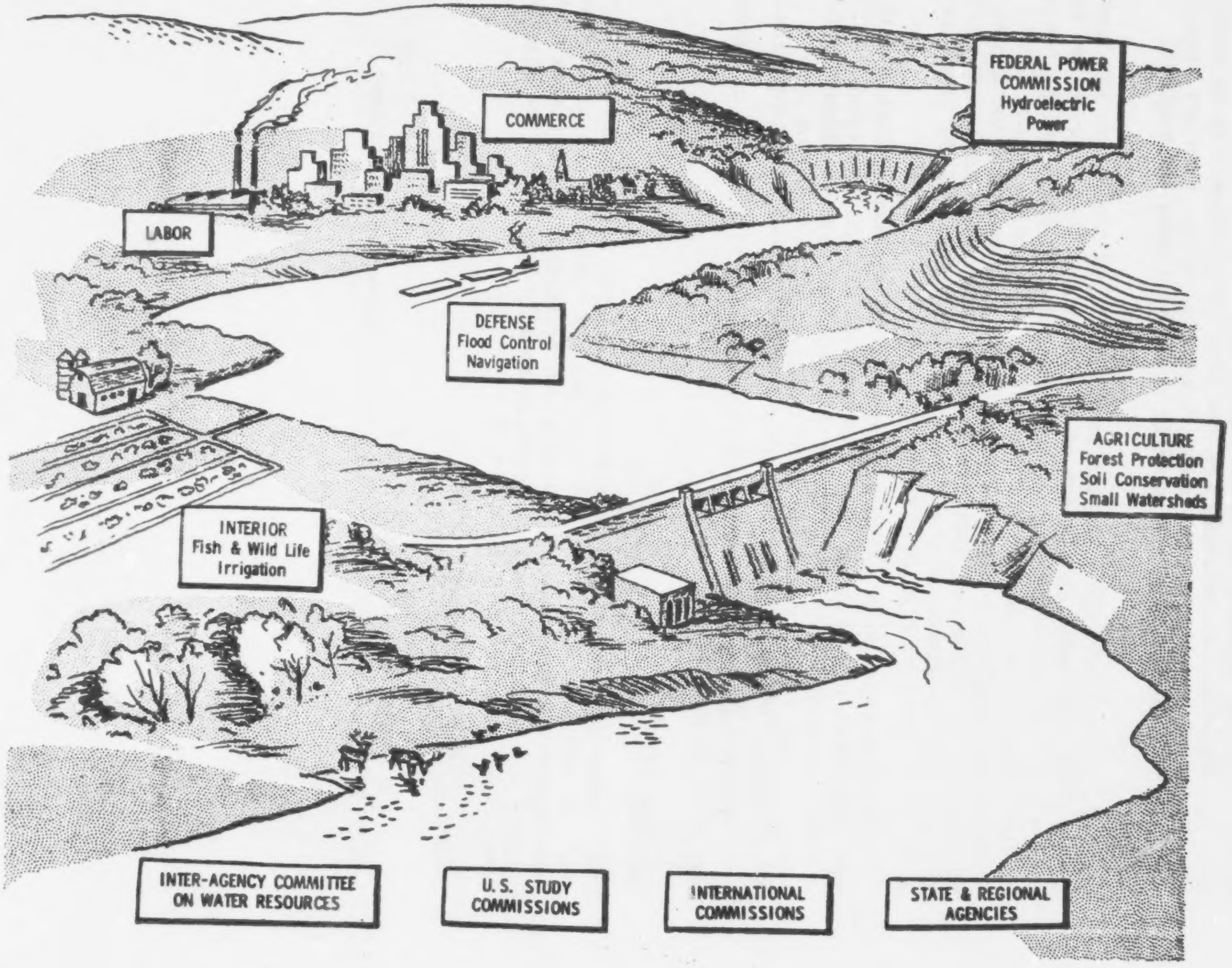
ADMINISTRATION

Under the present provisions of the Federal Water Pollution Control Act, as amended, the authorized programs are conducted and administered in the Department of Health, Education, and Welfare by the Division of Water Supply and Pollution Control, organizationally located in the Bureau of State Services in the Public Health Service.

Scope of Federal Program

The funds appropriated under P.L. 660 for the conduct of the Federal water pollution control program by fiscal years are as follows:

SERVICES TO OTHER WATER RESOURCE AGENCIES


FEDERAL POWER COMMISSION Hydroelectric Power
COMMERCE
LABOR
DEFENSE Flood Control Navigation
AGRICULTURE Forest Protection Soil Conservation Small Watersheds
INTERIOR Fish & Wild Life Irrigation
INTER-AGENCY COMMITTEE ON WATER RESOURCES
U.S. STUDY COMMISSIONS
INTERNATIONAL COMMISSIONS
STATE & REGIONAL AGENCIES

Activity	1957	1958	1959	1960	1961	1962	1963	1964
Total	$54,224,100	$51,491,000	$52,428,800	$53,851,300	$56,044,000	$100,973,260	$114,651,000[1]	$118,980,000
Research Grants	---	159,000	147,500	---	---	2,670,000	3,285,000	4,229,000
Fellowship Grants	---	---	---	---	---	100,000	300,000	450,000
Training Grants	---	---	---	---	---	700,000	1,100,000	2,000,000
Control Program Grants	2,000,000	3,000,000	3,000,000	3,000,000	3,000,000	4,800,000	5,000,000	5,000,000
Demonstration Grants	---	---	---	---	---	300,000	500,000	625,000
Comprehensive	Inc. in Tech. Services	Inc. in Tech. Services	Inc. in Tech. Services	465,000	1,508,100	2,840,000	4,568,000	5,499,000
Enforcement	250,000	350,000	367,800	491,400	1,347,500	2,847,000	2,915,000	3,624,000
Research	440,100	902,000	1,002,500	1,004,300	1,651,300	2,423,000	2,867,000	3,063,000
Basic Date	300,000	500,000	555,000	555,900	847,400	1,135,000	1,252,000	1,350,000
Technical Services	834,000	980,000	1,067,000	865,700	939,700	1,443,000	1,578,000	1,693,000
Construction Grants Services	400,000	600,000	632,000	633,000	649,000	1,070,000	1,286,000	1,447,000
Waste Treatment Works Construction	50,000,000	45,000,000	45,657,000	46,816,000	46,101,000	80,645.260	90,000,000	90,000,000

1/ Excludes $56,000 transferred to GSA for space

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CURRENT STATUS OF FEDERAL WATER POLLUTION CONTROL PROGRAM AND ACCOMPLISHMENTS IN CONTROLLING WATER POLLUTION

Federal Actions Under Public Law 660

THE WATER POLLUTION CONTROL ADVISORY BOARD

The Federal Water Pollution Control Act of 1956 established in the Department of Health, Education, and Welfare the Presidentially-appointed Water Pollution Control Advisory Board. The Board is composed of the Secretary or his designee, who is Chairman, and nine members appointed by the President, none of whom can be Federal officers or employees. The function of the Board is to "advise, consult with, and make recommendations to the Secretary on matters of policy relating to his activities and functions under this Act."

The Board members appointed by the President must be selected from among representatives of State, interstate and local governmental agencies, of public and private interests concerned with water pollution, and of other public and private agencies, organizations, or groups demonstrating an interest in water pollution prevention and control, as well as other individuals who are expert in this field. Each member is appointed for a term of three years (except appointments to fill unexpired terms) and cannot be reappointed within one year after his preceding term.

Over the years the Board has numbered among its members some of this country's most distinguished persons in public life, in government, in industry and in the broad fields of conservation and health.

The Board meets from four to six times a year. In recent years it has been the policy of the Board to meet in Washington, D. C. only once or twice a year, with other meetings scheduled at various cities throughout the country where serious water pollution problems exist. At these regional meetings, representatives of local and State governments, private organizations and industry are invited to meet with the Board and present information concerning these problems.

Examples of such regional meetings are:

1. The Board met in Oklahoma City, Oklahoma, on October 31, and November 1, 1957, at the invitation of the Governor of the State of Oklahoma, to inspect oil field pollution problems of interstate waters, and to become acquainted with the efforts and accomplishments of the oil industry in its attempt to eliminate such oil field pollution by disposal of the brine in earth cavities. Representatives of four of the largest oil producing companies of the State, as well as State officials,

members of the faculty of the University of Oklahoma and the general public discussed this problem in considerable detail. Cooperation of the oil companies and oil industry with State and Federal officials brought about corrective measures to materially eliminate this type of pollution.

2. The Board met in San Francisco, California, September 7 and 8, 1960, at the invitation of the Governor of California, and other State officials to observe first-hand the pollution caused by Federal installations of the San Francisco Bay area, which at that time was very acute. As a result of this meeting with high officials of the Army, Navy, and Coast Guard, as well as State and local officials, a national inventory of "Waste Water Disposal Practices at Federal Installations" was made and a report presented to the President with the recommendation of corrective measures.

3. The Board met in Western Montana on September 20, 21, 22, 1961, at the invitation of the two United States Senators from Montana to inspect the pollution of the Clark Fork River in that State. Although many conflicting interests were represented at this meeting, the discussions resulted in a promise for continuing progress in the initiation of aggressive pollution abatement programs by all concerned.

4. The Board met in St. Louis, September 27 and 28, 1962, at the invitation of the Governor of Missouri, to discuss the pollution of the Mississippi River from St. Louis downstream. This meeting is credited with assisting in the successful passage by the citizens of St. Louis of a $95 million bond issue for the construction of the necessary intercepting sewers, treatment works and other appurtenances. This is the largest single bond issue for this purpose in this country and will provide treatment of the city's wastes for the first time.

Regardless of its membership since the passage of Public Law 660, or the policies of two separate administrations, the Board has been very consistent in its efforts to support various phases of a growing, effective water pollution control and abatement program by the Federal Government. It has always vigorously sought an upgrading of the program and recommended to the Secretary that the Division of Water Supply and Pollution Control be given Administration status within the Department. For several years it gave strong support to establishing a public awareness and education program, now in operation and already enjoying outstanding success. In other areas, the Board has repeatedly recommended legislation which offered a tax incentive to industries to control and abate their own pollution; has been a prime mover in securing the inventory of waste disposal at Federal installations, as a means of encouraging Federal agencies "to show the way" in water pollution control; has been an active supporter of a strong Federal program through construction, research and demonstration grants; has recommended and encouraged effective enforcement procedures as a means of correcting and controlling pollution, and has sought better Federal-State relationships and cooperative assistance to State and local governments.

Present composition of the Water Pollution Control Advisory Board is as follows:

Chairman, Ex Officio

Hon. James M. Quigley
Assistant Secretary
Department of Health,
Education, and Welfare

Mr. John A. Biggs
Director, Department of Game

Mr. Earle G. Burwell
Member, Wyoming State Stream
Pollution Committee

Mr. Charles H. Callison
Assistant to the President
National Audubon Society

Mr. M. James Gleason
Commissioner, Multnomah County

Dr. Maurice K. Goddard
Secretary, Pennsylvania Department
of Forests and Waters

Executive Secretary

Mr. Robert C. Ayers
Department of Health,
Education, and Welfare

Mr. Lee Roy Matthias
Executive Vice President
Red River Valley Association

Mr. Ed E. Reid
Executive Director
Alabama League of
Municipalities

Mr. William E. Towell
Director, Missouri
Conservation Commission

Mr. William E. Warne
Director, California
Department of Water
Resources

Those who have previously served on the Advisory Board and their affiliation when appointed are as follows:

Name	Period of Service From	To
Milton P. Adams Executive Secretary, Michigan Water Resources Commission	1956	1959
Dr. Daniel Bergsma Commissioner, New Jersey State Department of Health	1956	1957
Morrison B. Cunningham Director of Public Works Oklahoma City, Oklahoma	1956	1958
Hon. Charles H. Elston Former Member of Congress (Ohio)	1956	1958
William A. Galbraith Director, Washington State Department of Conservation & Development	1956	1957
Fred C. Heinz Vice President H. J. Heinz Company (Pa.)	1957	1959
Charles R. Hook Chairman, Board of Directors Armco Steel Corporation (Ohio)	1956	1957
Dr. Howard P. Sawyer Sanbornville, New Hampshire	1956	1957
Carl D. Shoemaker Conservation Consultant National Wildlife Federation Washington, D. C.	1956	1957
Irwin T. Bode Former Director, Missouri Conservation Commission	1957	1960

Name	Period of Service From	To
Hon. William F. Duckworth Mayor of Norfolk Norfolk, Virginia	1957	1960
Dr. Harold M. Erickson State Health Officer Oregon State Board of Health	1957	1959
Anton Hulman, Jr. President, Hulman & Co. (Indiana)	1957	1960
Seth E. Gordon Director, California Department of Fish and Game	1958	1961
Frank Long Member, Wyoming Stream Pollution Control Advisory Council	1958	1961
William S. Wise Director, Connecticut Water Resources Commission	1958	1961
John S. Samson Chairman, Nebraska Water Pollution Control Council	1959	1962
Dr. Russell E. Teague Commissioner of Health Kentucky Department of Health	1959	1962
Dr. Clair S. Boruff Technical Director Hiram Walker and Sons (Illinois)	1960	1963
John Charles Daly Vice President, American Broadcasting Company (New York)	1960	1962

Name	Period of Service	
	From	To
Tom McCann Mayor of Fort Worth Fort Worth, Texas	1960	1963
Dr. Leroy E. Burney, Chairman Surgeon General Public Health Service	1956	1960
Dr. Luther L. Terry, Chairman Surgeon General Public Health Service	1960	1961

Research, Training, and Information

The Federal Water Pollution Control Act, as amended, provides for a broad program of research, training and information. Research is conducted within the Department by its own staff and is supported extramurally by research, training and demonstration grants to qualified institutions, agencies and individuals. Technical training is provided by the Department and graduate training of needed engineering and scientist personnel is supported through training grants and fellowships. An information program has been established to collect and distribute widely, information relating to the prevention and control of water pollution.

To support these research, training and information programs, and the other extensive field programs of the Department, the 1961 Amendments provide for the establishment of at least seven regional field laboratory and research facilities. The 1962 Appropriation Act authorized the establishment of two water quality standards research laboratories, one for fresh water and one for marine water.

Research and Training Grant Activities

Funds Appropriated - The research and training grant activities of the Division of Water Supply and Pollution Control involve four separate extramural programs. Each program has a specific function yet all are interrelated. Research grants and demonstration grants are directed toward the acquisition of new knowledge and the broadest, most rapid application of that knowledge. Training grants and research fellowships are awarded to develop the graduate training facilities of institutions and the research potential of individual scientists and engineers.

Funds Appropriated by Years

1962-1964

	1962*	1963	1964
Research Grants	$2,670,000	$3,285,000	$4,229,000
Research Fellowships	100,000	300,000	450,000
Training Grants	700,000	1,100,000	2,000,000
Demonstration Grants	300,000	500,000	625,000
Totals	$3,770,000	$5,185,000	$7,304,000

* 1962 - First year of appropriations for all programs.

Funds Allocated to Others and Purposes for Which Utilized - Because of the large number and complexity of water supply and pollution control problems requiring investigation, the studies which merit support cover a wide variety of scientific and technical disciplines. A basic objective of the research grant program is to develop a nationwide interest in research relating to pollution among the many scientific fields involved, and to encourage scientists to do research on neglected aspects of the problem. Research grants support a wide variety of basic and applied studies in fields such as sanitary engineering, chemistry, microbiology, oceanography and systems analysis. Eligible recipients of research grants are public and private non-profit agencies and institutions.

The majority of research grants are awarded to colleges and universities, since these institutions are the principal source of research manpower and possess the facilities requisite for research activity. This university orientation of research grants has a beneficial secondary effect in that grantee institutions generally employ graduate students to assist principal investigators in their work. Research grants thus provide a substantial supplement to graduate training supported by the formal training grant and research fellowship programs.

Demonstration grants are designed to expedite the application of basic research information to broad water supply and pollution control practice. These grants demonstrate the feasibility of new treatment methods and new pollution control techniques. They represent a wide variety of investigations, ranging from new engineering designs to new organizational concepts for the administration of water pollution control activities. Demonstration grants are open to the same potential grantees as research grants. However, because they involve pilot scale or field-trial investigations, State and local official agencies play a much larger role than in the research grants program. Approximately one-half of the demonstration grants are awarded to State and local health, water pollution, and wildlife agencies.

Extramural training activities of the Division of Water Supply and Pollution Control include programs of training grants and research fellowships. The critical manpower shortage in most areas of water supply and pollution control has dictated the need for a well-planned and intensive program of support and stimulation for the training of a wide variety of highly qualified scientific and technical personnel.

Training grants are awarded to non-profit educational institutions and at present are restricted to support of graduate training. These grants provide for establishment or expansion of training programs related to water supply and pollution control through funds for: (a) planning formal classroom, laboratory and field curricula; (b) improvment and expansion of faculty; and (c) stipends to students participating in the program. This program allows for more than one department of a grantee institution to provide specialized training courses. Encouragement is given to the development of training programs of a cooperative, interdepartmental nature. The end products of the training grant program are an increase in the number and quality of graduate educational programs in water supply and pollution control, and an increase in qualified manpower to fill a variety of research and teaching, administrative, and operating positions in the water field.

Research fellowships are awarded to individuals for the support of graduate and post-graduate research training of specialists in the field of water supply and pollution control. While training grants are aimed broadly at producing qualified personnel in all major fields of activity, there is definite need for the cultivation of special research talents. In all scientific areas, individuals capable of performing significant independent research are urgently needed. In the water pollution control area, this situation is particularly true because of the variety of scientists and engineers whose talents must be brought to bear on research problems.

Fellowship applicants must demonstrate interest in and competency to become career research scientists and engineers. They are free to choose their location of study and their research problem. If awarded a fellowship, the individual then embarks on an intensive course of study and research designed to expand his knowledge and sharpen his research potentialities. Following such training, these individuals will usually become expert research workers in Federal and State agencies, universities, and industries where they will continue a research-oriented career. Those who enter academic employment will also instruct others and thus become a part of the national training program in water supply and pollution control.

Applications for all research and training grant programs are received by the Division of Water Supply and Pollution Control and are reviewed on the basis of: (a) their overall scientific and technical merit; and (b) their compliance with Federal policies covering grants-in-aid.

Despite the newness of all of these grant programs, the number and variety of applicants and grantees has been highly gratifying. In 1963, for all four grant programs, a total of $5,184,239 was expended for 278 grants and awards. These grants and awards were made to 109 agencies, institutions, and individuals in 43 States, the District of Columbia, and five foreign countries.

Direct Federal Research Activities

In the Public Health Service, the Division of Water Supply and Pollution Control carries out a program of scientific research broadly directed to: (1) determining the causes and effects of pollution of the Nation's water resources, and (2) the development of the pollution prevention and control measures necessary to maintain the national water resources in a quality continuously suitable for domestic and municipal water supply, industrial and agricultural purposes, recreation, propagation of fish and aquatic life and wildlife, and other beneficial uses.

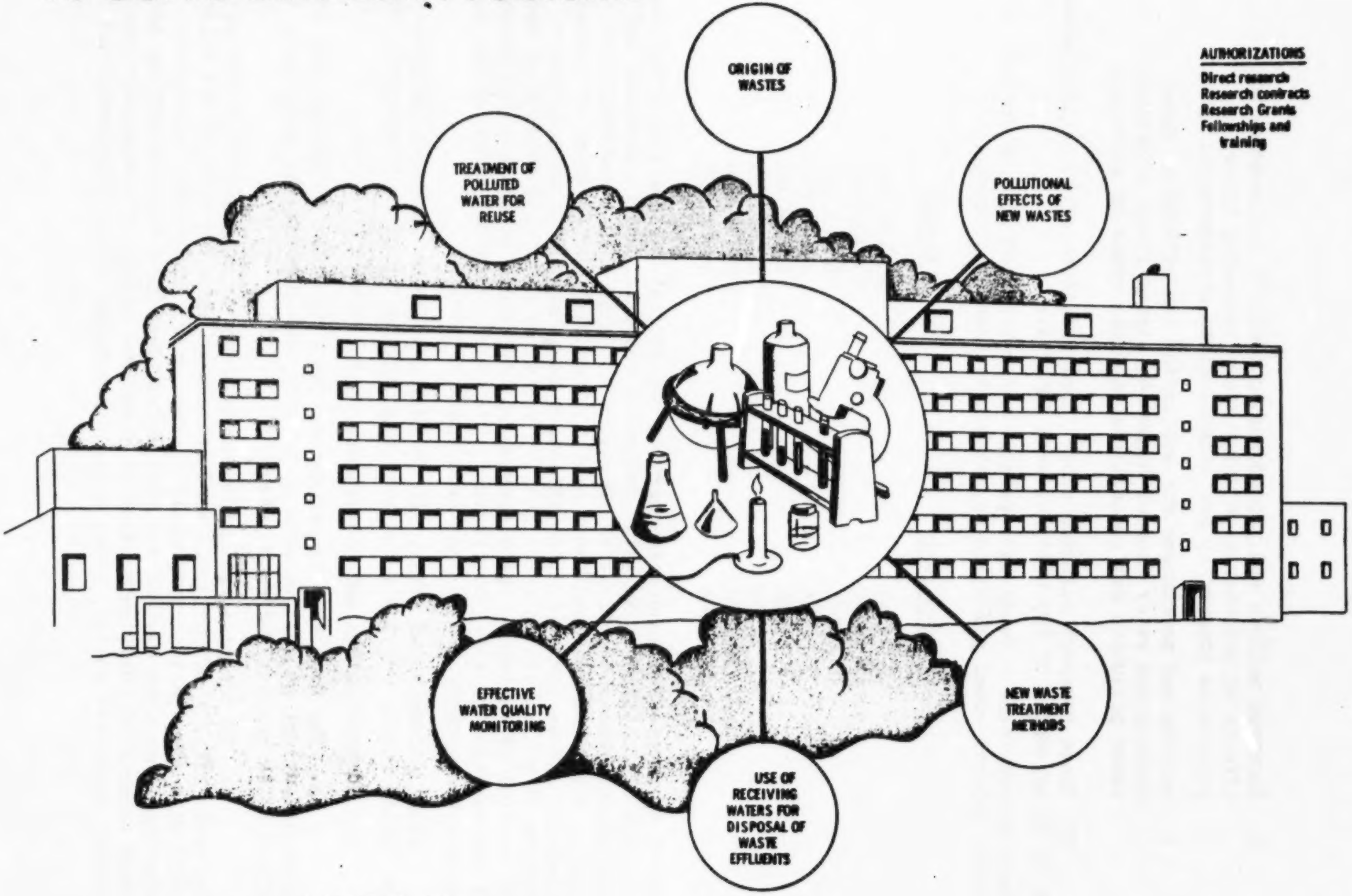
In recent years, unprecedented population and industrial growth and concentration, revolutionary new technologies, and changing land uses and practices have thrust enormous pollution problems on a relatively unprepared science. The researcher must now deal with new problems caused by the sheer mass of pollutants and by a whole host of new pollutants that are extremely complex in composition and persistent in water of which detergents, synthetic chemicals of a wide variety, and radioactive materials are already well-known examples.

The analytical tools and scientific knowledge which served well for the problems of the past are proving increasingly inadequate in dealing with present pollution problems and will become more so with foreseeable future problems. Thus, water pollution research must develop an effective new science while program administrators attempt to hold the pollution line with available knowledge.

Recognizing research needs in the 1961 Amendments, the Congress clearly indicated its intent that the Federal water pollution research program be accelerated. The Amendments direct the Secretary to undertake research in three specific areas--the development and demonstration of:

1. Practicable means of treating municipal sewage and other waterborne wastes to remove the maximum possible amounts of physical, chemical, and biological pollutants in order to restore and maintain the maximum amount of the Nation's water at a quality suitable for repeated reuse;

RESEARCH-
To Solve Difficult Problems


AUTHORIZATIONS
Direct research
Research contracts
Research Grants
Fellowships and training
ORIGIN OF WASTES
TREATMENT OF POLLUTED WATER FOR REUSE
POLLUTIONAL EFFECTS OF NEW WASTES
EFFECTIVE WATER QUALITY MONITORING
NEW WASTE TREATMENT METHODS
USE OF RECEIVING WATERS FOR DISPOSAL OF WASTE EFFLUENTS

THE PRINCIPAL AREAS OF NEEDED RESEARCH

2. Improved methods and procedures to identify and measure the effects of pollutants on water uses, including those pollutants created by new technological developments; and
3. Methods and procedures for evaluating the effects on water quality and water uses of augmented stream flows to control water pollution not susceptible to other means of abatement

For these research purposes alone appropriations of $5 million annually, up to an aggregate of $25 million, were authorized.

Funds Appropriated - Funds appropriated under P.L. 660 for the conduct of direct Federal water pollution research have been as follows:

Fiscal Year	Amount
1957	$ 440,100
1958	902,000
1959	1,002,500
1960	1,128,700
1961	1,632,000
1962	2,096,775
1963	2,867,000
1964	3,063,000

Use of Appropriated Funds - In carrying out Federal responsibility for leadership and accomplishment in water pollution research, and in planning and programming research activities, Division of Water Supply and Pollution Control scientists and engineers have defined eight broad areas of needed research. These are: (1) identification and measurement of pollutants; (2) effects of pollutants on water quality and water uses; (3) origins of wastes; (4) control of wastes at their source; (5) treatment of wastes; (6) disposal of wastes into the water environment; (7) water resources conservation and quality management; and (8) advanced waste treatment.

Within these broad areas, the following research is being conducted at the Public Health Service's Sanitary Engineering Center at Cincinnati, Ohio.

1. Identification and Measurement of Pollutants

a. The Problem - It is obvious that, in order to prevent and control water pollution, we must be able to identify and measure the pollutants that affect water quality and water uses.

In the past, pollution control was principally concerned with the gross effects of the total waste discharge on water quality and seldom dealt with the specific components in the waste. Therefore, laboratory determinations were devised and used which identified certain effects and gross amounts of pollutants, such as dissolved oxygen, biochemical oxygen demand, suspended solids, total solids, nitrogens (free, albuminoid and total), and rough determinations of toxicity to fish of certain suspected chemicals and wastes. Few of these laboratory methods were specific for individual pollutants, nor did they then need to be.

All this has changed in recent years. The changes in character, composition and strength of municipal sewage have been previously discussed. The conventional sewage treatment processes now in use are proving increasingly ineffective for the stronger, more complex and larger volumes of municipal sewage, making it increasingly necessary to detect and measure the individual components in sewage if new and effective treatment and controls are to be developed.

Industrial wastes have changed dramatically. Not only has increased production resulted in an increase in the common industrial wastes but process changes have altered their characteristics. Even more difficult, changing technologies are producing a wide variety of wholly new synthetic products and wastes of which little is known. A tremendous increase in the use of agricultural chemicals is creating a new land drainage pollution problem. Nuclear power developments and the increasing use of radioactive materials in industry, medicine and research may produce still other wastes which are undetected by the usual methods used to assess water and wastes.

Present methodology for detecting and measuring the presence and amounts of significant pollutants in water is particularly deficient. A whole new arsenal of analytical tools must be developed soon if we are to be able to adequately assess the water pollution problem, predetermine potential chronic toxic effects of pollutants, and devise effective, efficient programs and treatment methods for preventing and controlling pollutants.

b. Research Accomplishments - Examples of recent accomplishments in identification and measurement of pollutants are:

(1) Development of the membrane filter procedure for enumeration of coliform organisms which shortened the time required for this determination from days to hours.

(2) Development of the delayed incubation membrane filter test. Using this new procedure, incubation can be delayed as much as three days with reliable results, thus allowing bacterial samples to be collected and shipped great distances from the laboratory.

(3) Develomment of a procedure for identifying bacteria by infrared spectrophotometry. This method is much faster and less expensive than the traditional fermentation or antisera methods.

(4) The adaptation of the "most probably number" method to the estimation of concentration of viruses by the tissue culture technique. When applicable, this method is more accurate and less expensive than the "whole animal" method.

(5) Development of procedures for measuring radioactive substances in water and wastes.

(6) Development of an automatic dissolved oxygen analyzer for continuous sampling and recording of dissolved oxygen in effluents and streams.

(7) Procedures for detection and measurement of specific organic chemical compounds, including pesticides, by application of chromatographic separation techniques.

(8) A serological technique developed for the determination of biological sources of pollution.

(9) Radioactive carbon dating techniques developed and used to determine sources of specific pollutants.

(10) Carbon adsorption technique developed which recovers large amounts of organic chemicals from polluted waters, making possible specific analyses and pollutional effect studies, including toxicity.

2. Pollution Effects on Water Quality and Water Uses

a. The Problem - Many new wastes, particularly in the synthetic chemical field, are being discharged unheralded into waters where they appear as discrete pollutants. Little is known of them except that they are extremely persistent and stable in water and resist removal by conventional water and waste treatment methods. Some cause tastes and odors in drinking water, others are toxic to fish and aquatic life or taint fish flesh, and almost nothing is known of their toxic effect on humans except that present concentrations in natural waters appear not to be acutely toxic. Methods are needed to measure the pollutional characteristics of new wastes where traditional parameters no longer apply-methods which will accurately measure the effects of new pollutants on water quality and suitability for use. Methods are needed also for some of the older wastes and for natural pollutants, the pollutional effects of which have not been fully assessed.

b. Research Accomplishments - Among the accomplishments in determining the effects of pollution on water quality have been the development of:

(1) A standardized bioassay procedure for measuring the toxicity of specific chemicals and effluents to fish; equipment and methods for conducting long-term continuous flow bioassays; and a determination of principles involved in application of laboratory bioassay results and the major factors which may affect toxicity.

(2) A catalog of information on the toxicity to fish of various substances, including metal salts, metallocyanide complexes, detergents, pesticides, industrial organic chemicals, and selected industrial waste effluents.

(3) Information on the effects of specific industrial chemicals on conventional biological waste treatment processes on which tolerable limits can be determined.

(4) Basic knowledge on the role of algae and actinomycetes in producing tastes and odors in water, and on the role of nutrients in algal growth.

(5) Physiological, histological, histochemical and toxicological methods to determine the effects of sublethal concentration of toxicants on the life history stages of fishes, aquatic insects, and benthic organisms. These have been applied thus far to the effects of heavy metals, cyanides and alkyl benzene sulfonate (synthetic detergent).

(6) Measurements of the acute toxicity to fish, insects, crayfish and certain benthic organisms of the 10 most widely used chlorinated hydro-carbon pesticides, 15 most common organic phosphorous compounds, 10 widely used herbicides and algicides, 18 principal organic solvents, the principal nitrile compounds, cyanides and metallocyanides, raw catalytic cracking wastes, rocket propellants, and other materials.

(7) Basic knowledge on the environmental requirements for the propagation of fish from studies to determine dissolved oxygen requirements as related to temperature, dissolved gases, pH and other environmental factors such as stream current and diurnal fluctuations of light. These and other studies to be undertaken will lead to the establishment of water quality requirements for fish and aquatic life.

3. Origin of Wastes

a. The Problem - Our ability to account for the source of pollutants in the water resource is unsatisfactory, largely because its importance has been recognized only recently. With literally thousands of pollutants entering the water resource from municipal and industrial sewers, and from agricultural and urban land drainage, it is becoming increasingly necessary to be able to determine the source of these pollutants if control measures are to be devised and applied. Many pollutants in water have their origin in multiple sources. Man-made pollutants are intermixed with natural pollutants, including those resulting from natural chemical, biochemical, and biological reactions supported by man-made pollution.

Examples of concern are origin of salt pollution (oil field brines, natural salt deposits, irrigation return flows); nutrients (agricultural fertilizers, sewage and organic industrial waste effluents, natural stream purification, chemical manufactures); fecal streptococci (human, animal); mineralization (acid mine drainage, irrigation return flows, industrial wastes, water treatment); and many organic chemical wastes where it is necessary to trace their origins back to the specific manufacturing plant outfall sewers.

In addition to controlling wastes, it is necessary to be able to prove the origin of specific pollutants in enforcement actions where the specific rules of evidence apply.

b. Research Accomplishments - Although this area of research is relatively new, accomplishments are being made:

(1) Precise renumeration and classification of the fecal streptococci now permits a qualitative interpretation as to whether the source of fecal pollution is human and/or animal. This procedure has been useful in enforcement proceedings by helping to assign the amount of pollution from domestic sources (sewage) and from animal sources (meat packing plants, feed lots, etc.).

(2) Radioactive carbon dating procedures have been applied to organic materials recovered from water, making it possible to determine if the pollution materials originated from processing fossil fuels (coal, oil, natural gas) or the decay of vegetation.

(3) In response to expressed need by State and other conservation organizations for methods of fixing the cause of fish kills, a procedure has been developed to detect fish kills due to zinc. It is believed this procedure will be applicable to other heavy metals, and will be of real value in fixing the responsibility for fish kills from these sources.

(4) The analytical procedures developed by research under "Identification and Measurement of Pollutants" above are being successfully applied to techniques for tracing the origin of organic chemical pollutants to specific industrial outfalls. An outstanding example was the tracing for 1,000 miles up the Mississippi River of the chemical nitrochlorobenzene to the outfall sewer of its origin. This chemical, which is toxic to man in relatively low concentration, was removed from the company's waste effluent on notification of its detection.

4. Control of Wastes at Their Source

a. The Problem - Wastes can be broadly categorized as those which can be collected and conveyed to a central place for treatment (municipal sewage, urban storm drainage, and most industrial wastes), and those which cannot be collected and conveyed to a central place and therefore must be controlled at their source (acid mine drainage, natural and oil field brines, irrigation return flows and other agricultural drainage, etc.). Other situations that must be controlled at their source or place of occurrence are exemplified by algal blooms and other nuisance vegetative growths in lakes, streams and impoundments, and by the water quality deterioration that often results in water impoundments.

Concern over these problems is fairly recent but it is becoming very apparent that source controls for acid mine drainage, agricultural land drainage, natural brines, impoundment water quality, etc., need to be developed soon. This has been brought about by increased water use for all purposes and growing competition among all water users across the country.

b. Research Accomplishments - Much more research needs to be conducted in this important area but preliminary programs have been initiated:

(1) Studies on the pollutional characteristics of storm water, not mixed with sewage, showed that runoff from developed areas can have substantial pollutional impact on receiving waters. One residential-light commercial area has been studied intensively and it was found that annual flow of storm water runoff equalled in pollutional strength the domestic sewage from that area.

(2) Some 700 strains of actinomycetes, fungi and bacteria have been screened for natural products having anti-algal properties. Two actinomycete-produced substances have been shown to be active against blue-green algae. Research is under way to identify these substances to provide information needed for their large-scale production.

(3) A virus has been discovered which attacks and kills certain blue-green algae. This is the first report of a virus phage and may be of great importance to biological control of algal growths. Research is directed toward production of this phage so that it can be field tested.

5. Treatment of Wastes

a. The Problem - Present treatment methods for both municipal and industrial wastes were devised for the problems that existed 40 years ago, and are based fundamentally on mechanical and biological principles. These processes provide partial treatment at best and are proving to be increasingly inadequate for the concentration of today's wastes and entirely inadequate for many of the new synthetic chemical wastes. In addition, no satisfactory treatment methods were ever devised for many of the older wastes which are now being produced in quantities proportional to increases in manufacturing production--pulp and paper, metal finishing, food processing and textile wastes being examples.

Water treatment is considered to be an extension of waste treatment since its function is also the removal of contaminants. Water treatment processes were also developed long ago and are not designed to remove the contaminants in solution. Since raw waters are containing increasing amounts of soluble pollutants (synthetic detergents, pesticides, organic chemicals, etc.), these substances are reaching the public in larger amounts through its drinking water. Although the present level of these substances is relatively low and no acute or chronic effects on humans have been demonstrated, the industrial production forecasts for these substances show a real need to improve the effectiveness of existing water and waste processes.

b. Research Accomplishments - Effort has largely been directed towards improving the efficiencies of existing water and waste treatment processes, adaption of these processes to new wastes or to older wastes where this has not been done, and development and evaluation of new treatment aids and devices:

(1) The effect of specific chemicals, both organic and inorganic, on waste treatment systems and receiving streams has been examined. An exhaustive study of the tolerance of conventional sewage disposal systems to metallic wastes promises to greatly extend the amount of metallic wastes which sewage disposal plants can safely accept, and to lay the groundwork for more effective usage of municipal waste treatment facilities in the support of industry.

(2) Knowledge has been obtained on the treatability by activated sludge of many substances of industrial origin. These include cyanide, cyanate, thiocyanate and a host of organic cyanides. A massive review of the amenability of organic material to biological treatment was prepared as a companion to this work.

(3) Studies on the metabolism of specific materials by activated sludges using radioactive tracers, and on the effect of temperature on activated sludge, promise to increase the efficiency of waste treatment by the activated sludge process.

(4) A modification of the normal activated sludge system promises to facilitate removal of nitrogen in sewage, and thereby to reduce the amount of this important nutrient-promoting growth of nuisance algae in production of odors in the stream.

(5) An anaerobic contact waste treatment device was developed in the laboratory and tested in a housing subdivision serving 350 families. This new treatment device was demonstrated to produce a stable effluent with low oxygen demand and low suspended solids. It required little care and its installation costs were low. The unit appeared to have distinct advantage as a plant for treating the sewage from housing subdivisions and small commercial establishments.

(6) Research and studies of waste stabilization ponds have developed basic knowledge of the natural purification phenomena of this process which resulted in improved design criteria and performance. The stabilization pond has provided a low cost waste treatment method, both as a permanent treatment process and as a temporary one until interceptor sewers reach the area.

(7) Research has been conducted on the basic phenomena of the trickling filter treatment process, involving fluid resident time in relation to size and roughness of filter media, rate of waste application, temperature, viscosity, biological activity and filter depth. Similar studies of synthetic filter media have also been made. Data from these studies should be useful in improving trickling filter design and performance.

(8) A method was developed for converting sulphite liquor sugars to fumaric acid through a fermentation process utilizing strains of a fungus, Rhizopus. Fermentation was carried out in liquors containing 19% solids which is approximately twice the concentration of usual sulphite mill effluents. Twenty-eight percent solids were too high for efficient operation and the best yeild was at 14 percent solids. This process shows promise both as a treatment method and a by-product recovery method.

(9) A method was developed for the direct utilization of algae in destruction of the wood sugars in waste sulphite liquor. In experiments it was found that after 236 hours, there was a reduction in the wood sugars of 62 percent. In a 1 percent sugar solution, 70 percent of available sugar was used by a green algae in 120 hours. The possibility of using algae to break down organic wastes without depending on a symbiotic relationship with bacteria was thus further advanced.

(10) Research on water purification processes showed that a conventional water treatment plant, properly operated, can effectively remove viruses in the raw water. Filtration alone cannot be depended on in virus removal. However, chemical coagulation followed by filtration, and disinfection with free residual chlorine provide dependable protection against viruses reaching the treated water supply.

(11) An evaluation of water purification processes and their ability to remove several common fish poisons, pesticides, and alkyl benzene sulfonate, showed that the use of activated carbon in proper dosages reduced these materials in the treated water to levels that could not be detected.

(12) An evaluation of synthetic organic coagulant aids for use in water treatment, improved knowledge of coagulation processes, and intensive studies of sand filters have provided a basis for increased rates of water treatment without cost increase or reduction of finished water quality.

(13) A household-scale pasteurizer was researched, designed and tested to provide dependably safe individual water supplies for rural and other areas where waters of questionable quality are used. This pasteurizer has been marketed commercially.

(14) Microbiological research showed for the first time that, in demand free systems, certain common viruses were more resistant than bacteria to the disinfecting action of free chlorine, combined chlorine, and iodine.

6. Disposal of Wastes into the Environment

a. The Problem - While wastes have been discharged into streams, lakes, and coastal and ground waters for many years, little is known of the most effective means of their dispersal to prevent pollution problems, or the capacity of these waters to assimilate wastes. This is becoming an increasing problem for the 23 States located on coastal waters, the eight States located along the Great Lakes, and the larger cities on the Nation's streams. There are also several million persons dependent on septic tanks and soil absorption systems for waste disposal. The basic principles of waste disposal in waters and soils must be defined and applied.

b. Research Accomplishments - This is another relatively neglected research area now beginning to receive attention. Impetus to this research is being added by the need to make the most effective use of augmented stream flows from impoundments in controlling water pollution not otherwise susceptible to abatement.

(1) Investigations on the use of the soil mantle in waste disposal showed that the use of top soil to assimilate wastes can be improved considerably to the great advantage of areas where disposal to surface water is not feasible or

desirable. It was found that the environment provided by the soil permitted the destruction of such persistent chemical substances as alkyl benzene sulfonate. Design criteria for disposal of wastes in soils will be recommended following further study of such factors as soil characteristics, waste characteristics, acclimatization time with soil bacteria, rate and pattern of waste application in the soil.

(2) Viruses in the effluents of septic tanks have been shown to be as effectively removed by soil as are bacteria at the rates with which these wastes are normally applied to the soil assimilation system. In properly designed systems, therefore, there is little chance of ground water contamination by the microorganisms.

(3) Procedures for time of flow in streams of pollutants have been developed using radioactive tracers.

(4) Control of pollution by oils has been advanced by studies of the treatability of oils, the travel of oil in a natural watercourse, and development of a technique for differentiating between oily materials from several sources.

7. Water Resource Conservation and Quality Management

a. The Problem - The severe drouth in the Southwest during the 1950's and others of less extreme nature in recent years in other parts of the country, have demonstrated the close relationship of water quantity and quality. Obviously, if the amount of pollution remains constant as quantity decreases, water quality must deteriorate. Two areas of water conservation research presently appear appropriate to water pollution research: ground water recharge and evaporation reduction. Small-scale research programs are in progress.

b. Research Accomplishments - To supplement the research of other agencies in ground water recharge and reservoir evaporation control, research and studies are underway and findings show that:

(1) An important factor affecting adversely the value of monomolecular films of hexadecanol in reservoir evaporation reduction is the rapid destruction of the film by bacteria present in the water. It has been determined that one percent silve sterate added to the hexadecanol can significantly prolong the useful life span of the monolayer. Other bactericidal agents are being studied.

(2) Research is needed to determine the fundamental causes of soil clogging and persistence of chemical pollution in ground waters. This work is also related to the use of sewage effluents and other treated wastes as sources of water for recharge in water short areas. Some of the findings from

research in septic tank disposal are being applied to this research, and other studies are in progress.

8. Advanced Waste Treatment

a. The Problem - Water supply and pollution trends show that one of the most pressing problems in water quality management is the need to develop new treatment processes which will remove much more of the contaminants from municipal wastes than is possible by present biological methods. The volume, strength and complexity of future municipal wastes can only result in the discharge of larger and larger amounts of impurities into badly needed water resources if we continue to apply presently known treatment processes only.

In amending the Federal Water Pollution Control Act in 1961, the Congress recognized the need for reuse of water and, consequently, the need to develop much more effective processes for removing contaminants from waste waters. The 1961 amendments direct the Secretary of Health, Education, and Welfare to--

> "develop and demonstrate under varied conditions (including conducting such basic and applied research, studies, and experiments as may be necessary): (A) Practicable means of treating municipal sewage and other waterborne wastes to remove the maximum possible amounts of physical, chemical and biological pollutants in order to restore and maintain the maximum amount of the Nation's water at a quality suitable for repeated reuse;"

In response to this directive a major research project has been established in the Public Health Service, presently called the advanced waste treatment research program. The objectives of the program are twofold: (1) to reduce the level of pollution of the Nation's water resources to the minimum practicable level to permit repeated downstream water uses, including recreation and propagation of fish and aquatic life and wildlife; and (2) to reclaim waste waters for deliberate reuse by the same municipalities and industries producing the waste waters. Similar work begun by the Public Health Service in 1960 has been made a part of this major research project.

Since biological treatment methods, even after years of refinement, do not begin to remove all the contaminants in today's wastes, the advanced waste treatment research program is directed toward developing chemical-physical processes which separate the wastes from water or the water from the wastes. The long-range program is planned to follow the basic research-pilot study-demonstration plant procedure as is implied by the language in the 1961 amendments.

Two important objectives must be achieved if the total concept of advanced waste treatment is to be feasible. First, it will be essential to concentrate the impurities in municipal waste water into small volumes and provide for permanent disposal of this concentrate. Second, it will be necessary to produce purified water of a quality suitable for direct reuse. Concentrated wastes removed by advanced waste treatment processes cannot, of course, be discarded back into surface waters. If this were done, stream pollution problems would not be diminished and downstream water users would have to remove the same contaminants again and again. The development of methods for permanently disposing of concentrated impurities is, therefore, an important part of the concept. Efficient removal of contaminants will result in the production of water of excellent quality. Provision should be made for deliberate direct reuse of this water by the community or industry since in most cases, it would be wasteful to discharge an excellent water into a stream which is less pure, perhaps much less pure, than the treated discharge. The development of a successful advanced waste treatment technology, therefore, could lead in one step, to the alleviation of both water pollution and water supply problems.

From a technical standpoint, advanced waste treatment may be looked upon as a two-step process: (1) Separation of concentrated contaminants from the purified water product, and (2) disposal of the concentrated contaminants in a way that renders them forever innocuous. Research is necessary, therefore, on both separation and permanent disposal techniques. These two elements of advanced waste treatment are related economically since, in general, the further waste is concentrated, the higher the cost of concentration but the lower the cost of disposal.

Although their objectives are similar, there are a number of important differences between advanced waste treatment and saline water conversion. First, there is the problem of permanent disposal of the concentrated wastes. When a saline water conversion plant is situated on the ocean's shore, concentrated waste brine can be dumped back into the sea which serves as an infinite waste sink. However, in Kansas City, Cincinnati, or any inland city, there is no suitable place to dispose of the concentrated wastes from a water renovation plant. Therefore, the concentrated wastes must be disposed of permanently and advanced waste treatment researchers must strive for product-to-waste ratios which are much higher than those considered satisfactory for saline water conversion. While a 1:1 ratio, i.e., one volume of waste brine for each volume of product, is satisfactory for desalination, ratios of at least 1:100 and very possibly 1:1000 must be achieved in waste water renovation. Such a requirement makes one problem much different technically from the other.

Second, the types of impurities causing problems in waterborne wastes are quite different from those found in saline waters. In waste waters there are obviously significant quantities of organic materials which are not found in large amounts in the sea. There may also appear a broad spectrum of industrial wastes as well as biological and even radioactive pollutants.

Third, the physical and chemical characters of the feed streams are distinctive. Theoretically, the carrier fluids for both saline waters and waste waters are the same, H_2O. Practically, however, the feed streams are quite different--one is salt water, the other fresh. This difference is reflected in the properties of the two streams; for example, the viscosity, thermal conductivity, ohmic resistance, freezing point depression, boiling point elevation, and corrosivity. These factors can have a significant bearing on the technological feasibility, engineering process design and, most important, on the economics of the various separation techniques under study.

Fourth, waste water renovation is a dynamic problem, while saline water conversion is a static problem. In any one location, for example, the feed water composition to a desalination plant should remain relatively constant. It is not expected that the composition of the sea will change appreciably over the next 50 to 100 years; but in an advanced waste treatment plant, the process must be capable of accommodating a feed stream which is changing in composition and concentration from hour to hour. It also must accept changes from day to day, from season to season, and certainly long-term changes from year to year. To illustrate, 25 years ago synthetic detergents were not found in waste waters; today they are. Today there are no soluble packaging materials present, but it is anticipated that 5 years from now such materials will be a common component of municipal wastes. Feed composition will vary geographically as well. More and more, the composition of a municipal waste stream will reflect the wastes from the area's industrial complex.

Finally, the types of treatment processes which must be considered encompass not only those capable of purifying saline waters but many others based on entirely different principles of separation. This is required by the dissimilar nature of both concentration and composition of impurities.

It is conceivable that almost any physical-chemical principle of separation is applicable to advanced waste treatment. Principles under active consideration include adsorption, electrodialysis, emulsion separation, evaporation, extraction, foaming, freezing, hydration, ion exchange, and chemical or electrochemical oxidation . None of these unit operations have been applied to municipal waste treatment.

b. Research Accomplishments - The first phases of this research were carried out by contracting with leading physical chemists in universities and industries for evaluations of the application to waste treatment of fundamental physical-chemical processes. These are now the subject of large-scale studies, intramurally and by contract, to establish the feasibility of applying these principles to the treatment of wastes. The following significant findings and conclusions have been made:

(1) Extramural Activities

Adsorption:

(a) Activated carbon is an effective adsorbent for most organic components in waste waters and may adsorb 20 or 30 percent of its weight of organics.

(b) Chemical regeneration of the carbon was tried using chlorine, bromine, potassium permanganate, sodium dichromate, sodium persulfate, sodium peroxide, hydrogen peroxide, and ozone. Most effective: hydrogen peroxide in 3 percent solution. However, over-all cost was not favorable.

(c) Thermal regeneration does appear to be practical. Preliminary cost projections by the Pittsburgh Chemical Company in which 50 ppm organic material is reduced to the ppm level range for 5-10 cents/1000 gallons.

(d) Activated bauxite has shown some promise as an adsorbent and asbestos has some interesting properties of adsorption. These studies are continuing. Preliminary tests on a wide variety of minerals, ash, etc., have not indicated that the materials are valuable for waste water treatment.

(e) Fundamental studies of factors affecting adsorption have been completed by Harvard University. Some findings: very slow equilibrium in some cases; small particles important; rate controlling factor is diffusion; initial concentration of solute important; low pH beneficial in ABS adsorption; column operations better than batch.

(f) Preliminary costs of carbon use--5-10 cents per 1000 gallons of waste.

(g) Common materials as adsorbents not very promising.

Coagulation:

(a) Minerals, industrial by-products, proteinaceous substances, and conventional water treatment agents were tested on secondary effluents. Regenerable, aldehyde-hardened, granular proteinaceous materials showed promise in removing organic refractory substances. The economics do not look promising.

(b) Use of the sludge blanket for coagulation-adsorption combines the virtues of batch coagulation (finely-divided, high surface area forms of solids) and columnar bed adsorption (high flow rates).

(c) Electrodes made of platinum-coated titanium, lead dioxide, and stainless steel appear to be the most promising. Copper, aluminum, magnesium, and lead were attacked severely during electrolysis. Carbon and graphite were seriously attacked except at very low temperature or current density.

(d) Current density, temperature, and initial pH have little effect on the performance of lead dioxide in an electrolytic cell. Effect of these parameters on other electrode materials is being determined.

Electrodialysis:

(a) Standard membranes adsorb organic components of waste waters, including ABS. This results in eventual fouling and requires either regeneration of the membranes by an acid-acetone mixture or removal of organics prior to introduction of the sample to the electrodialysis unit. Current reversal was unsuccessful in removing ABS from the membranes.

(b) Asbestos has some capacity for adsorbing organic materials and asbestos diaphragms have been incorporated into electrodialysis stacks to serve as adsorbing units. These eventually require regeneration.

(c) Incorporation of ion exchange beads into the cell spaces of the electrodialysis stack serve to remove ABS and other organics but will themselves require regeneration.

(d) Special membranes have been made containing large pores and very small pores. While the large pore membranes permit some ABS to pass, water also passes. The small pore membranes exclude some organic ions but eventually foul.

(e) On inorganics, electrodialysis may be the method of choice for controlling ion concentrations.

Evaporation:

(a) The major question regarding the feasibility of evaporation as an advanced waste treatment process is the "scaling tendency" of municipal waste waters; other factors requiring investigation prior to "screening" evaporation either in or out of consideration are corrosion and foaming. Preliminary analysis of inorganic scaling tendency indicate that temperatures of above 300°F may be practical without scaling.

(b) Assuming there are no major obstacles in the above areas, it appears that evaporation of municipal waste waters can be accomplished more cheaply than evaporation of sea water because of (1) lower boiling point elevation, (2) lower volume of feed to be handled per unit of product water, (3) lower volume of brine to be disposed of per unit of product water, and (4) higher top temperatures possible.

(c) The possibility of blending product water from an evaporator with untreated or partially treated waste water significantly reduces the potential cost of an evaporation-based renovation system.

Extraction:

(a) Preliminary work indicates that, when extracting with diisopropylamine, foaming does not occur and the phases separate reasonably fast.

(b) The cost of the extraction process increases with increasing concentration of impurities. Therefore, waste water renovation should have greater potential than desalination of either brackish or sea water by the extraction process.

(c) Batch extractions have indicated that relatively organic-free water can be produced. Essentially all of the ABS and some of the other COD materials remain in the solvent phase. Continuous lab-scale equipment is being set up to determine effect of this on efficiency of solvent.

(d) Tritiation of the organic content of waste waters is being considered as a method for following course of organics during treatment. This would eliminate need for COD determination and reduce sample size needed.

Foaming:

(a) ABS removals of 90-95 percent can be obtained.

(b) An air to liquid ratio of 3:1 will reduce ABS to 0.5 ppm.

(c) Foaming in a second column in series with the first can reduce ABS concentration to 0.2 ppm.

(d) COD removals of 10-45 percent can be attained; average removal is 30 percent.

(e) Percent COD removal depends on ratio of COD to ABS concentrations in feed.

(f) Use of additives has given COD removals up to 65 percent.

(g) Volume reductions on foaming average 125:1.

(h) Residence times of 2.5-4 minutes are required.

(i) Proteins and detergents act synergetically to enhance foam stability.

(j) Prefoaming increases adsorption capacity of activated carbon by up to 30 percent.

(k) Costs of foaming are estimated at less than 5 cents/1000 gallons for 10 mgd.

Freezing:

(a) Organic refrigerants interfere in the COD test and must be accounted for.

(b) Formation of foam in the freezer (particularly when using a secondary refrigerant) is a problem that must be solved.

(c) It is possible that ABS and other COD-bearing organics adsorb on the ice crystals. This must be further explored.

(d) A eutectic between pure water and sodium chloride has been formed in the laboratory at -21°F. The two solid phases were mechnically distinct, rather pure and easily separable.

Hydration:

(a) A hydrate eutectic has been formed between water, NaCl and freon 31. The temperature and pressure measured for this system were very close to those predicted.

Permanent Disposal:

(a) Preliminary cost estimates indicate that disposal of advanced waste treatment concentrates may be accomplished by at least several processes increasing in cost in the following order: spreading; injection; placement in cavities; wet oxidation; and incineration.

(b) Cost estimates for disposal of 100,000 gpd of concentrate range from .01 dollars/1000 gallons of concentrate for spreading to $20/1000 gallons of concentrate for incineration. At a 500:1 product:waste ratio this is equivalent to 1/500 cents/1000 gallons product water to 4 cents/1000 gallons product water.

(2) Intramural Activities

Analytical Section:

(a) A modified COD test has been developed which eliminates chloride interference and greatly enhances the usefulness of this test.

(b) Some effects of light hydrocarbons in water have been studied. Included were taste and odor, explosion hazard and analysis. This work was primarily for the Office of Saline Water.

(c) Analytical procedures are taught to contractors and improvements in procedures are sought. New tests found in the literature are evaluated. A foaming test is being sought.

Project and Methods Section:

(a) Oxidation - Significant results to date include:

Catalytic oxidation of organics in secondary effluents is feasible with H_2O_2 at 200 ppm and 150°F. Low pH values (3.3-4.1) and $H_2O_2:Fe^{++}$ ratios of 10:1 to 20:1 enhance this oxidation.

Approximately 50-70 percent reduction of secondary effluent COD's is achieved by an oxidation mechanism. An additional 15 percent COD removal occurs due to simultaneous coagulation and sedimentation.

Phosphates and possibly chlorides appear to inhibit H_2O_2oxidation to some extent. This can be overcome through use of additional Fe^{++} catalyst.

ABS in secondary effluents can be reduced by about 98 percent (down to 0.10-0.15 ppm) by catalyzed oxidation with H_2O_2 at ambient temperatures. Less catalyst is required as reaction temperature is increased.

(b) Stabilization of Waste Water Effluents - Because of the need to study real effluents which are biologically stable, a series of studies have been undertaken to pasteurize or otherwise treat effluents to maintain this stability:

> Heat treatment of unfiltered primary effluents at 180°F for 10 minutes and storage at 40°F holds COD of effluents stable for 60 days.
>
> Promising results are being obtained by treating previously pasteurized effluents with antibiotics to hold at room temperature. Two or three ppm of antibiotic (Polymoxin B, or Kanarycin) to 100 ppm COD is the dosage.

Regional Field Laboratory and Research Facilities

Recognizing the national scope of the water pollution problem, the principle of Federal-State-local cooperation established by P.L. 660, the differences in the kinds of pollution problems in the various regions of the country, and the need to provide laboratory and research services in support of pollution control programs close to the problems, the 1961 Amendments direct the Secretary of Health, Education, and Welfare to establish and maintain at least seven regional field laboratory and research facilities.

These laboratories will support research, surveys, studies and investigations of water pollution on a regional basis. This approach will permit much broader, more comprehensive consideration of the demographic, economic and water supply factors involved in water quality management than is possible by dealing with individual pollution situations or even a river basin. When in operation, the cooperative water pollution control research effort will, for the first time, be national in scope.

The statutory responsibilities in the Federal Water Pollution Control Act requiring laboratory and research services in addition to direct research relating to the causes, control and prevention of water pollution, are:

1. The development of comprehensive water pollution control programs for river basins.

2. Special field study projects on specific pollution problems.

3. Technical assistance to other Federal agencies, State and interstate water pollution control agencies.

4. The enforcement of interstate water pollution control.

5. Collection and evaluation of basic data.

6. Control of pollution from Federal installations.

7. Technical training of personnel of public agencies and other qualified persons.

During calendar year 1962 and early 1963, the Public Health Service investigated 54 locations in 25 states proposed for laboratory sites. Survey teams visited the areas and prepared reports based upon criteria established for evaluation of proposed laboratory locations. The Secretary has selected laboratory sites for six of the seven regions named in the Amendments.

Region	Location
Southwest	Ada, Oklahoma
Pacific Northwest	Corvallis, Oregon
Southeast	Athens, Georgia
Midwest	Ann Arbor, Michigan
Northeast	Boston, Massachusetts
Alaska	College (Fairbanks), Alaska

The location has not yet been selected for the Middle Atlantic region.

A total of $12,490,000 was provided in FY 1963 and FY 1964 for construction of the laboratories at Ada, Corvallis, Athens, Boston, and College.

The transition from a planning and construction program for field laboratories to an operational situation, is now being programmed. The basic staffing guides for the laboratories at Ada, Corvallis, and Athens have been completed and operating plans are now being developed which will be phased with construction schedules.

Water Quality Standards Research Laboratories

The water pollution control administrator--local, State, interstate or Federal--is required to make decisions. Such decisions are required whether the administrator is dealing with an individual problem of pollution or with the development and operation of a comprehensive water quality management program for a river basin. The validity of his decisions is dependent upon the scope and reliability of the data available to him. The more comprehensive the water quality management program, the more complex and difficult the pollution situation, and the more variables affecting water quality, the more necessary reliable data become.

Water quality standards are basic tools on which management decisions must be based. If such decisions are to be consistently reliable, these standards need to be derived through scientific research.

Many important needs would be served by the determination and application of reliable water quality standards. Such standards would, when applied in water pollution control programs:

1. Protect the public from infectious biological agents and from pollutants having acute and chronic toxic effects.

2. Provide a healthy environment for the propagation of fish and aquatic life and wildlife.

3. Permit orderly development of water supply of adequate quality for a growing population and an expanding industry.

4. Provide for equitable distribution of water resources among all water users.

5. Allow for planning and administration of the most economical water quality management programs.

6. Provide a reliable base for determining storage requirements for augmenting stream flows for water quality management purposes, and for the most economical and beneficial releases of stored waters for these purposes.

7. Tend to eliminate economic advantages and disadvantages among States now having different water pollution control requirements.

8. Serve in locating sources of supplies for water uses having specific quality requirements.

9. Facilitate reaching agreements in interstate pollution situations and will insure that water qualities agreed upon will result when pollution control measures are effected.

10. Provide a reliable methodology for detecting and measuring the effects of pollutants on water quality, particularly for those pollutants resulting from new technologies for which such procedures do not now exist.

The problem with respect to standards now in use is that few are based on scientific research and therefore represent judgment or opinion rather than fact. As a result, there is little uniformity in existing standards and a wide range of values can be found for any given standard.

In the pollution situations where Federal enforcement actions have been instituted and in many more existing situations, interferences caused by pollution are sufficiently recognizable and evident and do not require substantiation on a finely detailed scientific basis. Technical and scientific intelligence and data presently available are fully utilized; however, the absence of accepted standards of quality for each of the respective water uses has not served to withhold or to postpone the exercise of enforcement authority. Future instances of the application of enforcement measures will similarly proceed on a case-by-case basis accompanied by the use of new developments in intelligence and techniques, including water quality standards, as these become available and accepted.

The past 20 years have seen a very rapid growth in governmental functions and responsibilities in water pollution control. Generally, the newer State legislation establishes, or provides for establishing, water quality criteria in the form of classifications or standards. This trend toward water quality classifications or standards has been followed by most of the interstate agencies and many of the special boards and commissions dealing with water pollution.

Up to the present time a total of 45 State water pollution control agencies, six formal interstate agencies, five informal interstate groups and the International Joint Commission have legislation or agreements which establish, or provide for establishing, some form of water quality standards or criteria. Standards in use among these agencies range in detail from the simple requirement of primary sewage treatment as a minimum to complex systems of stream classifications and water quality standards. It is noted that while many of these agencies have authority to establish water quality standards, few have done so, largely because there is little reliable data on which to base such standards or to reach agreements.

In 1914 the Public Health Service published for the first time its "Drinking Water Standards" and these were revised in 1925, 1942, 1946, and 1961. The Standards were promulgated for use by interstate carriers and others subject to the Federal Quarantine Regulations; however, most State health agencies and the American Water Works Association have adopted them as criteria for public water supplies.

In recent years a growing number of important conferences, organizations and individuals, recognizing the value and need of reliable water quality standards, have urged and recommended that a scientific research program be undertaken to develop comprehensive water quality standards for all water uses. Many of these representations have requested or recommended that such research be undertaken by the Public Health Service. Much of this has resulted from growing concern over the lack of knowledge regarding the newer contaminants, particularly detergents, radioactive materials, and new chemicals.

The 1962 Public Health Service Drinking Water Standards set limits for these substances for the first time. The limit for alkyl benzene sulfonate (the active ingredient in most synthetic detergents) was set at 0.5 milligrams per liter of water; for carbon chloroform extract (containing most of the newer synthetic chemicals present in a given water), 0.2 milligrams per liter; and for radioactivity, aggregate amounts of Radium-226 and Strontium-90 not exceeding 3 to 10 uuc per liter respectively, and in the known absence of Strontium-90 and alpha emitters, gross beta concentration not to exceed 1,000 uuc per liter.

Responding to the increasing concern for reliable water quality data and recommendations that research be conducted to establish reliable water quality standards for all water uses, the Congress authorized the establishment of two National Water Quality Standards Research Laboratories in the 1962 Appropriations Act. One of the laboratories is for fresh water research and the other for marine waters.

In the FY 1963 Appropriation Act, $4,000,000 was included for the construction of these laboratories. Locations have been selected by the Secretary of Health, Education, and Welfare, at Kingston, Rhode Island, for the marine waters facility, and Duluth, Minnesota, for the fresh water laboratory.

The goals of these national laboratories will be the determination of water quality criteria for all water uses, with emphasis on quality required for the production and protection of aquatic life and wildlife. The research programs will be carried out in close cooperation with the advice of scientists and engineers expert in the water quality field, and with representatives from industry, agriculture, conservation organizations, and State and local government. The extramural aspects of the program will be encouraged and supported by grants and contracts for research and demonstrations.

Very broadly, the cooperative research program will consist of:

1. A continuing review of the literature, and the storage and retrievel of pertinent research findings.

2. An evaluation of all existing standards and research to determine their validity.

3. The development of a reliable methodology to detect and identify water pollutants, and to measure their effects on all beneficial water uses.

4. The establishment of, and agreement on, water quality requirements for all beneficial water uses.

5. Determination of the specific effects of water pollutants on all beneficial water uses, including acute or chronic toxic effects.

6. The establishment of, and agreement on, the allowable limits of water pollutants for each beneficial water use (water quality standards).

7. A continuing review and updating of all accepted water quality standards as water quality requirements and pollution problems change, and as new research alters the situation.

To comply with the intent of the Congress, the first priority in the establishment of water quality standards will be given to those for aquatic life. Concurrently, research will also proceed to establish standards for other beneficial water uses.

Training Activities

The growing shortage of skilled personnel in all fields of engineering and science, together with the increasing diversity and complexity of water supply and pollution control problems, makes training a matter of high priority. There is a real need to improve and accelerate the flow of information resulting from research and technological improvements to the practicing engineers and scientists in the field. There is a responsibility in the Federal program to help develop the skills of its own staff if it is to do its own job well, and provide leadership and assistance to others. To meet these needs, the Division of Water Supply and Pollution Control carries out the following direct training activities:

1. Short-term, intensive lecture and laboratory technical training courses at the Sanitary Engineering Center and in the field for personnel from other Federal, State, interstate and local agencies and from industry. These are special courses designed to train practicing personnel in the latest research and technical developments.

2. Sponsorship of seminars and conferences on special subjects of interest at the SEC designed to focus the attention of specialists on specific problems, progress and needs.

3. Long-term, outside-the-service training at the postgraduate level for career development of Division personnel who have a satisfactory academic background, outstanding work performance, and an expressed interest in a Federal career in water supply and pollution control. Such long-term graduate training in selected universities will provide for the development of highly specialized skills, including those in shortage catagories difficult to recruit.

4. Short-term, outside-the-service training in university and other teaching institutions to allow Division personnel to keep abreast of developments in their specialty, or to broaden the scope of their technical capability.

Funds Appropriated

Funds are appropriated specifically for the technical training programs carried out at the Sanitary Engineering Center. Funds for the training of Division personnel and for seminars are included in the budgets of operating programs sponsoring the training or the seminar.

Technical Training
Funds Appropriated by Years

Fiscal Year	Amount
1957	$ 54,000
1958	50,000
1959	50,000
1960	79,200
1961	104,200
1962	161,760
1963	160,000
1964	173,000

In addition to the appropriated funds for technical training, a considerable effort is represented in the use of research scientists and technical services personnel as teaching staff in the courses given.

The cost of out-of-service graduate training of Division personnel at universities this fiscal year will average a little less than $10,000 per individual. The cost of short-term in-service advanced training of professional persons varies from a few dollars to a few hundred dollars, depending on the nature of the course and the period of attendance.

Purpose for Which Funds Were Utilized

Direct Training activities have been carried out as follows:

a. Technical Training - A series of intensive, highly specialized short-term technical courses have been presented over the years at the Sanitary Engineering Center, and in response to needs at various locations across the country. These technical courses are designed and conducted by a full-time staff of experts, supplemented by research scientists and engineers of the Division. In addition, recognized authorities from other Government agencies, universities and industry contribute their knowledge and experience as course lecturers and consultants.

Trainees come from all parts of the country and represent a wide variety of professions and employing organizations. Training acitvities are not restricted to U. S. citizens. Individuals from foreign countries attend the courses, sponsored by their own governments or an international assistance program. In addition, two courses specifically designed for Latin American engineers have been conducted at the request of the Pan-American Sanitary Bureau of the World Health Organization in conjunction with the Administration for International Development.

From FY 1957 through FY 1962, a total of 2931 trainees have attended technical training courses at the Center and in the field. Over these years there has been a decided increase in requests for field courses so that training can be made more widely available to those unable to go to the Center. Although more courses have been offered at the Center in recent years, there is a growing number of applicants which cannot be accepted because of limited training facilities and resources.

The following list of technical training courses being offered during FY 1963 gives an indication of the variety of subject matters covered at the Center and at field training institutes:

Sanitary Engineering Center

Period	Course Title
October 1-12, 1962	Plankton Identification and Control
October 15-26, 1962	Bio-Oxidation of Industrial Wastes
November 26-30, 1962	Radioactive Pollutants in Water
December 3-7, 1962	Radionuclides in Water
December 3-14, 1962	Chemical Analyses for Water Quality
February 18-22, 1963	Recent Developments in Water Bacteriology
March 4-15, 1963	Water Quality Management
April 15-26, 1963	Organic Industrial Wastes Characterization
April 29-May 3, 1963	Inorganic Industrial Wastes Characterization
June 17-28, 1963	Aquatic Biology for Engineers

Period	Field Training Institutes
July 16-20, 1962	Water Quality Studies (Oregon State University, Corvallis, Oregon)
August 20-24, 1962	Water Quality Studies (East Central State College, Ada, Oklahoma)
September 10-21, 1962	Recent Developments in Water Bacteriology Water Quality Studies HEW Region VIII

	Seminars (SEC)
August 13-17, 1962	Third National Seminar on Biological Problems in Water Pollution (sponsored by Basic and Applied Sciences Branch, DWS&PC) Attendance: 436
April 3-5, 1963	Symposium on Stream Flow Regulation for Water Quality Control (sponsored by Technical Services Branch, DWS&PC) Attendance: 360

The following tables show the growth of the technical training program, the number of trainees attending and their professions, employing organizations and geographical distribution.

Technical Training

Number of Trainees

Fiscal Year	Total Trainees [1]	Applicants Rejected [2]
1957	1197 [3]	--
1958	209	--
1959	249	--
1960	262	--
1961	403	5
1962	611	45

[1] Includes trainees of regular, field, and special courses.

[2] Indicates number of applicants rejected due to lack of space.

[3] Includes 781 trainees attending a series of special, one-day courses in "Household Sewage Disposal" given at various locations other than SEC.

Technical Training

Geographical Distribution of Residence (SEC) Course Trainees
By DHEW Regions

	Regions								Foreign or Unknown
Fiscal Year	I & II	III	IV	V	VI	VII	VIII	IX	
1957				NOT AVAILABLE					
1958	14	25	10	37	17	10	6	20	7
1959	20	29	17	32	14	11	2	14	14
1960	34	33	9	41	9	12	5	18	30
1961	42	48	12	51	21	13	8	22	36
1962 1/	92	51	13	99	19	26	21	30	40

1/ Figures for Fiscal Year 1962 include trainees for field courses as well as regular SEC courses.

Technical Training

Employing Organizations of Residence (SEC) Course Trainees

Employer	1957 1/	1958	1959	1960	1961	1962 1/
Health and Health Related Agencies						
State	494 2/	31	39	36	44	117
Local		4	6	3	7	27
PHS	32	15	16	36	48	74
Other Federal (or Foreign)	--	--	--	--	33	7
Sub-Total	526	50	61	75	132	225
Other Agencies						
Federal:						
Defense	--	32	10	10	19	7
Other	21	1	3	3	13	7
State	--	22	18	20	16	31
Local	--	13	23	17	18	33
Colleges and Universities	30	4	4	11	10	23
Industry	606	16	11	25	40	49
Consulting Firm	--	--	--	--	--	4
Other (or Foreign)	--	7	15	30	5	8
Unknown	14	1	8	--	--	4
Sub-Total	671	96	92	116	121	166
TOTALS	1197	146	153	191	253	391

1/ Figures for FY 57, 62 include trainees for field courses as well as regular SEC courses.
2/ Includes State and Local

Technical Training

Residence (SEC) Course Trainees by Professions

Professions	1957	1958	1959	1960	1961	1962 1/
Administrator	NOT AVAILABLE	-	-	-	-	18
Bacteriologist		7	13	14	14	--
Biologist		11	14	7	16	31
Chemist		34	35	52	65	86
Dentist		-	-	-	-	--
Engineer		79	70	85	125	184
Health Educator		-	-	-	-	7
Industrial Hygienist		-	-	-	-	1
Microbiologist		-	-	-	-	24
Nurse		-	-	-	-	1
Pharmacist		-	-	-	-	--
Physician		-	4	1	-	1
Physicist		1	-	1	4	1
Sanitarian		3	1	3	4	10
Technician		5	5	6	5	9
Veterinarian		-	-	-	-	1
Other		6	11	22	20	17
TOTAL		146	153	191	253	391

1/ Figures for FY '62 include trainees for field courses as well as regular SEC courses.

b. Out-of-Service Training - In order to meet its needs for highly skilled personnel, particularly those in the so-called "shortage" categories in engineering and science, the Division has steadily increased its long term out-of-service advanced training program. Since 1956, a total of 49 persons have received advanced university training in engineering and sciences relating to water supply and pollution control.

Four employees have received or are candidates for doctorates, one in oceanography, one in water resources economics, one in water resources management, and one in advanced mathematics, statistics and sanitary engineering. The other 43 employees have received advanced university training in such specialized subjects as organic chemistry, physical chemistry, microbial chemistry, soil chemistry, industrial wastes, limnology, ecology, fresh water biology and salt water biology. Twelve of these employees received training in sanitary, civil or public health engineering. Nineteen employees have been selected for long term out-of-service training during fiscal year 1964. The following table shows the increase in the long term out-of-service training:

Long Term Out-of-Service Training

Fiscal Year	No. of Trainees	Fiscal Year	No. of Trainees
1957	2	1961	11
1958	2	1962	11
1959	3	1963	17
1960	4	1964	19

To enable employees to keep up with advances in their specialized fields, employees are encouraged to undertake short term training related to Division responsibilities and program objectives. In the past two years, 45 employees have been approved for and have received special training, principally by part-time attendance at universities in day or night classes.

Information

Prior to the National Conference on Water Pollution Control in December 1960, the Federal information program was limited in scope. The Conference called attention to a much greater need than was previously realized to build public awareness of the pollution problem. In March 1961, the Water Pollution Control Advisory Board considered this need and passed a strong resolution that an effective program be created and adequately supported. The Board has maintained its interest and support since that time.

As a result, the present program of information, and technical and citizen reports was instituted in 1961. This program has as its objectives to: (1) develop a greater public knowledge of the country's water pollution contro; and (2) provide communication skills to others in the field, both within the Government and outside.

These objectives have been pursued in three areas of activity: (1) a mass media campaign; (2) an education and information campaign on the national level, and (3) a similar activity on the local level. These programs are administratively directed by an Information Branch within the Division of Water Supply and Pollution Control.

Mass Media Campaign - The "Clean Water" mass media campaign has been a most successful accomplishment of the public awareness program. It is carried on with the support of the Advertising Council and the National Association of Broadcasters, and has the support of State and local governments and the principal civic, conservation, and women's organizations of the country. Last year, the first series of radio and television announcements received large amounts of contributed time estimated to be worth $7 million. A second series is to be released early in May 1963.

In this radio and television activity, major help has come from Mr. John Charles Daly, for three years a member of the Water Pollution Control Advisory Board and currently honorary president of the Izaak Walton League. Mr. Daly has appeared in both series of filmed announcements.

A National Program of Information and Education - This program is aimed at stimulating and assisting newspapers, magazines, and both network and local radio and television stations in developing information and education material on water pollution problems. This involves developing program material, making it available, and encouraging special programs or coverage. Nearly all of the country's largest circulation magazines, and each of its three national television networks have featured programs concerned with water pollution in the last two years. This has been supplemented by a large number of articles, features, and shows in smaller-circulation and regional media.

Local Level Program of Information and Education - The "local" program involves working with regional, State, and municipal agencies, with citizen groups of all kinds, and with local news media in developing local and regional interest in water pollution control problems and programs. They are encouraged to and assisted in developing their own information and education programs.

The Information Branch is also developing technical and editorial services to the Federal program and to others. These services include press and other media information; the preparation of booklets, brochures; visual aids and other materials; the provision of editorial, illustration, and art work; and the production and distribution of information and education materials.

GRANTS FOR WATER POLLUTION CONTROL PROGRAMS

An appropriation of $5 million annually is authorized (through F.Y. 1968) for the purpose of making grants to State and interstate water pollution control agencies to assist them in meeting the costs of establishing and maintaining adequate water pollution control programs. Allotments are made on the basis of population, extent of the pollution problem and the financial need of the respective States.

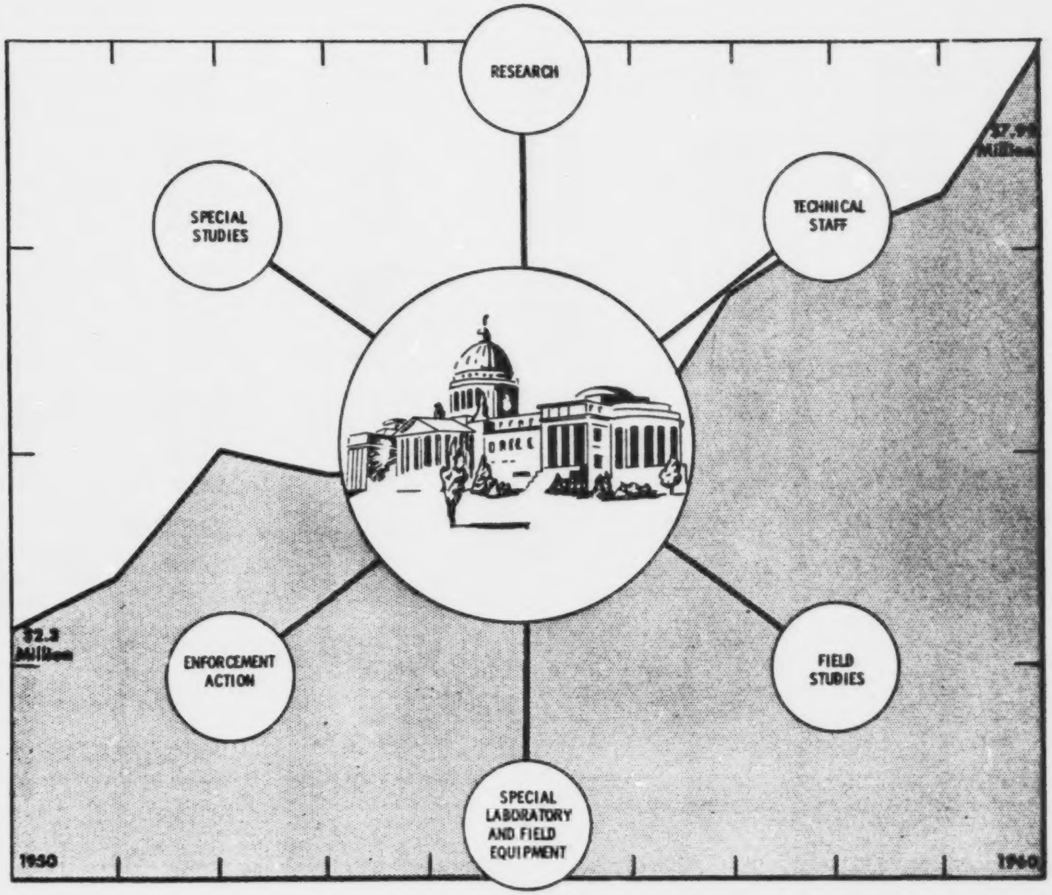
Funds Appropriated - Funds for program grants under P.L. 660 have benn appropriated as follows:

Appropriations for Federal Program Grants

Fiscal Year	Total	States	Interstate Agencies
1957	$2,000,000	$1,800,000	$200,000
1958	3,000,000	2,700,000	300,000
1959	3,000,000	2,700,000	300,000
1960	3,000,000	2,700,000	300,000
1961	3,000,000	2,700,000	300,000
1962	4,800,000	4,500,000	300,000
1963	5,000,000	4,700,000	300,000
1964	5,000,000	4,700,000	300,000

The following table shows how these funds were allotted among the State and interstate agencies:

PROGRAM GRANTS
Expand State and Interstate Programs



INCREASED ACTIVITIES AND APPROPRIATIONS UNDER PROGRAM GRANTS

Allotments to State and Interstate Agencies
for Water Pollution Control Programs
Fiscal Years 1957 - 1963

State	Federal Share (Percent) of Program Costs (1962 - 1963)	Federal Allotment 1957	 1958	 1959	 1960	 1961	 1962	 1963
Total		$1,800,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$4,500,000	$4,700,000
Alabama	66 2/3	38,256	59,100	57,800	56,800	55,700	93,700	97,300
Alaska	40.82	13,023	15,400	15,300	13,800	13,600	15,100	15,300
Arizona	54.39	17,318	22,500	23,300	23,500	23,400	34,700	37,600
Arkansas	66 2/3	29,529	41,500	40,000	39,200	38,300	61,200	62,300
California	39.38	75,130	127,100	132,900	133,700	134,400	259,000	275,500
Colorado	51.41	20,751	28,400	28,900	29,000	28,300	42,600	43,700
Connecticut	33.64	31,294	45,900	46,600	46,700	47,000	80,600	82,100
Delaware	33 1/3	21,769	29,400	29,400	29,600	29,600	46,300	45,300
Dist. of Col.	33 1/3	23,236	32,000	31,600	31,600	31,600	46,300	47,500
Florida	54.41	33,654	53,600	56,600	59,400	61,600	107,200	116,000
Georgia	64.67	40,576	62,200	62,000	61,500	61,000	105,300	109,200
Hawaii	51.72	18,547	24,000	24,400	24,900	25,600	34,500	37,700
Idaho	58.95	16,006	19,300	19,300	19,400	19,300	25,400	26,300
Illinois	39.17	67,976	110,000	109,400	110,600	112,200	190,500	205,900
Indiana	51.03	40,819	63,700	64,800	64,800	65,100	107,900	115,100
Iowa	54.44	30.365	44,400	44,800	45,300	44,100	67,800	70,800
Kansas	53.91	24,484	34,800	34,900	34,800	34,100	52,700	54,400

State	Federal Share (Percent) of Program Costs (1962 - 1963)	Federal Allotment						
		1957	1958	1959	1960	1961	1962	1963
Kentucky	65.05	36,447	54,900	54,400	54,300	54,400	65,000	69,600
Louisiana	62.95	34,817	52,600	52,200	51,500	51,000	86,400	91,700
Maine	59.14	19,331	24,900	24,900	25,000	24,900	35,500	36,800
Maryland	45.97	33,007	50,000	50,200	50,700	50,900	36,200	37,600
Massachusetts	43.65	50,358	77,000	75,000	74,100	74,000	130,800	134,000
Michigan	47.04	55,373	90,500	94,600	95,500	97,000	165,800	177,000
Minnesota	54.15	33,385	49,600	49,000	49,000	48,700	79,400	83,000
Mississippi	66 2/3	34,538	50,100	50,200	49,900	49,400	76,400	80,700
Missouri	51.48	38,342	59,000	57,900	57,300	56,200	93,800	97,200
Montana	52.96	15,415	18,000	18,300	18,500	18,500	23,400	24,400
Nebraska	53.55	20,797	27,900	28,100	28,100	27,500	38,400	39,900
Nevada	37.71	12,864	13,700	13,900	14,000	14,100	15,600	16,100
New Hampshire	54.27	18,537	23,400	23,600	23,700	23,700	32,200	34,600
New Jersey	39.27	48,391	75,600	77,400	78,200	78,900	140,400	145,900
New Mexico	58.30	17,052	21,000	21,100	20,900	20,700	29,200	30,900
New York	37.38	104,577	173,900	166,400	164,800	165,900	296,900	307,900
North Carolina	66.44	48,248	77,000	76,200	76,100	75,300	128,200	131,600
North Dakota	62.88	16,957	20,500	20,100	19,900	19,400	25,500	25,800
Ohio	45.49	66,988	110,200	110,800	110,700	113,300	201,000	213,300
Oklahoma	59.09	27,374	38,700	38,800	38,700	37,800	60,300	62,400
Oregon	51.22	21,785	29,700	30,100	30,100	29,800	44,600	45,800
Pennsylvania	48.07	82,462	134,100	132,100	131,000	130,900	232,000	241,300
Rhode Island	50.55	25,780	36,000	36,200	36,400	36,700	58,900	58,500
South Carolina	66 2/3	33,184	50,300	50,500	50,600	50,500	79,100	82,800
South Dakota	62.69	16,936	20,800	20,800	20,700	20,000	26,400	26,900

State	Federal Share (Percent) of Program Costs (1962 - 1963)	Federal Allotment						
		1957	1958	1959	1960	1961	1962	1963
Tennessee	65.27	40,509	61,900	61,100	60,200	59,600	100,000	105,300
Texas	55.73	62,605	103,000	103,800	104,700	104,900	185,500	196,500
Utah	57.42	17,158	21,300	21,600	21,700	21,600	29,200	31,000
Vermont	59.42	16,626	19,600	19,500	19,400	19,200	25,100	26,300
Virginia	58.11	37,771	57,100	57,100	58,400	58,900	94,700	101,800
Washington	47.54	26,555	38,200	38,500	38,900	39,200	61,700	65,300
West Virginia	61.47	29,331	42,200	41,300	39,800	39,100	56,900	60,100
Wisconsin	51.57	39,472	61,100	60,200	60,500	60,700	97,400	102,600
Wyoming	50.43	13,633	15,000	15,000	15,000	14,900	17,400	17,700
Guam	66 2/3	--	--	--	--	--	42,400	41,200
Puerto Rico	66 2/3	40,286	61,100	60,200	60,200	60,500	102,000	102,400
Virgin Islands	66 2/3	20,376	26,800	26,900	26,900	27,000	41,500	40,300
Interstate Agency								
Total	--	200,000	300,000	300,000	300,000	300,000	300,000	300,000
Bi-State Development Agency	43.46	12,081	18,200	18,300	17,600	17,600	18,100	18,100
Interstate Commission on the Delaware River Basin	41.27	28,575	42,800	42,800	41,400	41,400	42,100	42,100
Interstate Commission on the Potomac River Basin	50.79	16,013	24,100	24,200	23,300	23,200	23,600	23,700

Interstate Agency	Federal Share (Percent) of Program Costs (1962 - 1963)	Federal Allotment 1957	1958	1959	1960	1961	1962	1963
Interstate Sanitation Commission	37.41	43,048	64,600	64,300	63,200	63,200	68,600	68,600
Klamath River Compact Commission	39.09	--	--	--	6,900	6,800	7,500	7,600
New England Interstate WPC Commission	39.81	36,599	54,500	54,000	52,900	52,800	42,900	42,800
Ohio River Valley Water Sanitation Commission	45.92	63,684	95,800	96,400	94,700	95,000	97,200	97,100
GRAND TOTAL		$2,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$4,800,000	$5,000,000

Utilization of Appropriated Funds - In general, Federal program grants have stimulated many States to increase their own water pollution control appropriations since they are, in effect, matching grants. The availability of these larger funds have in many cases materially assisted the State and interstate agencies to extend and improve their programs in dealing with the pollution situations for which they are primarily responsible. Differences in State plans and reporting make it somewhat difficult to summarize the purposes for which these funds were used. However, the broad purposes and proportion of funds used were:

Program Purpose	Percent of Funds
Basic stream surveys and field investigations	21
Research and special studies	20
Construction related activities	14
Enforcement of pollution abatement measures (including some stream monitoring and surveillance of waste treatment facilities)	13
Program administration	13
Laboratory services	13
Central administration	3
Other and unspecified	3

Of the funds used to extend and improve State and interstate programs, about 60 percent on the average was expended for personnel and personal services, 13 percent for supplies and equipment, 14 percent for contracts and the remainder for training and miscellaneous purpose.

Accomplishments in Strengthening State Water Pollution Control Programs

The impact of Federal grant funds on State water pollution control programs can be most easily measured in terms of the effect on the State appropriations for this purpose. In 1956, the year prior to the beginning of the grant program, the States spent a total of $4.2 million for their water pollution control activities. For the past fiscal year (1963) approved budgets indicated that State expenditures for this purpose approached $9.3 million. (See attached table)

While it will be noted that the bulk of the dollar increase can be attributed to a few large States, it should also be noted that during the period since 1956, 30 States have more than doubled the amount of State funds devoted to water pollution control programs. In six instances the increase has been 10-fold or more.

While other influences have been at work in producing this remarkable increase, it is clear that Federal program grants have been a powerful stimulus to State financial participation.

A major advance made possible by these increased financial resources has been the enlargement of professional and technical staffs. Man-years devoted to the program by professional and technical personnel, including those spending full time on the program and those whose duties encompass other professional public health activities, have increased from 366 at the beginning of the grant program to 759 at the beginning of fiscal year 1964. Clerical and sub-professional categories have shown similar growth.

Improvement of State programs has also been made possible through the acquisition of such needed items of equipment as mobile laboratories and radiation monitoring equipment, through professional training provided for staff members and through special studies financed by contracts with universities.

In short, program grants have helped to establish programs where only minimal activities existed previously and to extend and improve programs which were already in operation.

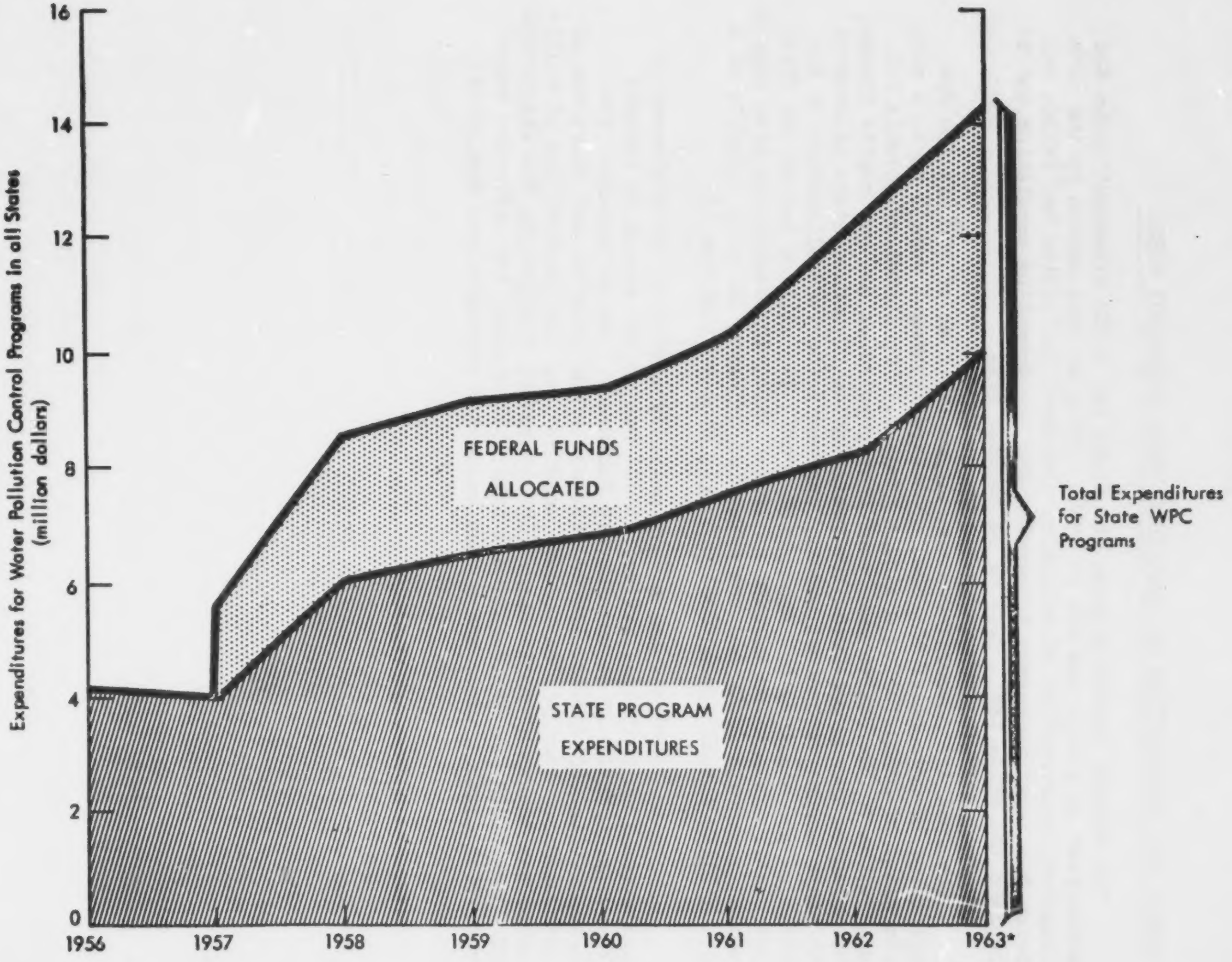
State Funds Utilized for Water Pollution Control Programs

F. Y. 1956 and 1963

State	1956 Expenditure	1963 Provisional Expenditure
Total	$4,216,243	$9,277,145
Alabama	45,898	45,156
Alaska	10,000	16,518
Arizona*	1,898	47,241
Arkansas*	18,312	101,645
California	466,183	869,593
Colorado	322,049	341,388
Connecticut	117,682	107,036
Delaware*	49,406	108,870
D. C.*	1,500	30,677
Florida*	65,603	516,374
Georgia*	31,196	109,279
Hawaii*	30,406	76,076
Idaho	25,329	41,061
Illinois*	129,596	280,349
Indiana	110,800	132,045
Iowa	39,250	73,044
Kansas	104,720	147,985
Kentucky	64,331	96,156
Louisiana	70,000	68,243
Maine*	44,625	114,694
Maryland	117,598	187,262
Massachusetts*	78,096	194,642
Michigan	128,257	229,610
Minnesota	94,415	86,076
Mississippi*	5,501	176,979
Missouri*	43,000	108,455
Montana*	12,000	30,068
Nebraska*	6,600	22,733
Nevada*	20,500	41,573
New Hampshire*	48,188	98,562
New Jersey*	101,581	267,167
New Mexico*	28,295	148,142
New York*	126,500	1,239,393
North Carolina	135,601	154,203
North Dakota*	7,500	42,393
Ohio*	149,730	603,916
Oklahoma*	12,813	41,885
Oregon*	49,726	150,421
Pennsylvania	652,998	783,366
Rhode Island	40,559	61,350
South Carolina	82,912	59,217
South Dakota	27,600	15,852
Tennessee	62,001	93,274
Texas*	46,200	340,190
Utah*	12,000	25,607
Vermont*	31,005	72,337
Virginia	84,070	132,892
Washington	127,782	205,322
West Virginia*	40,925	132,915
Wisconsin	78,436	145,130
Wyoming*	5,000	33,210
Guam	--	000
Puerto Rico*	--	23,842
Virgin Islands*	--	5,721

* States for which 1963 funds are more than twice those for 1956.

Figure 2 EXPENDITURES FOR WATER POLLUTION CONTROL IN ALL STATES DURING FUNCTIONAL PERIOD OF THE PROGRAM GRANTS.



*1963 estimated

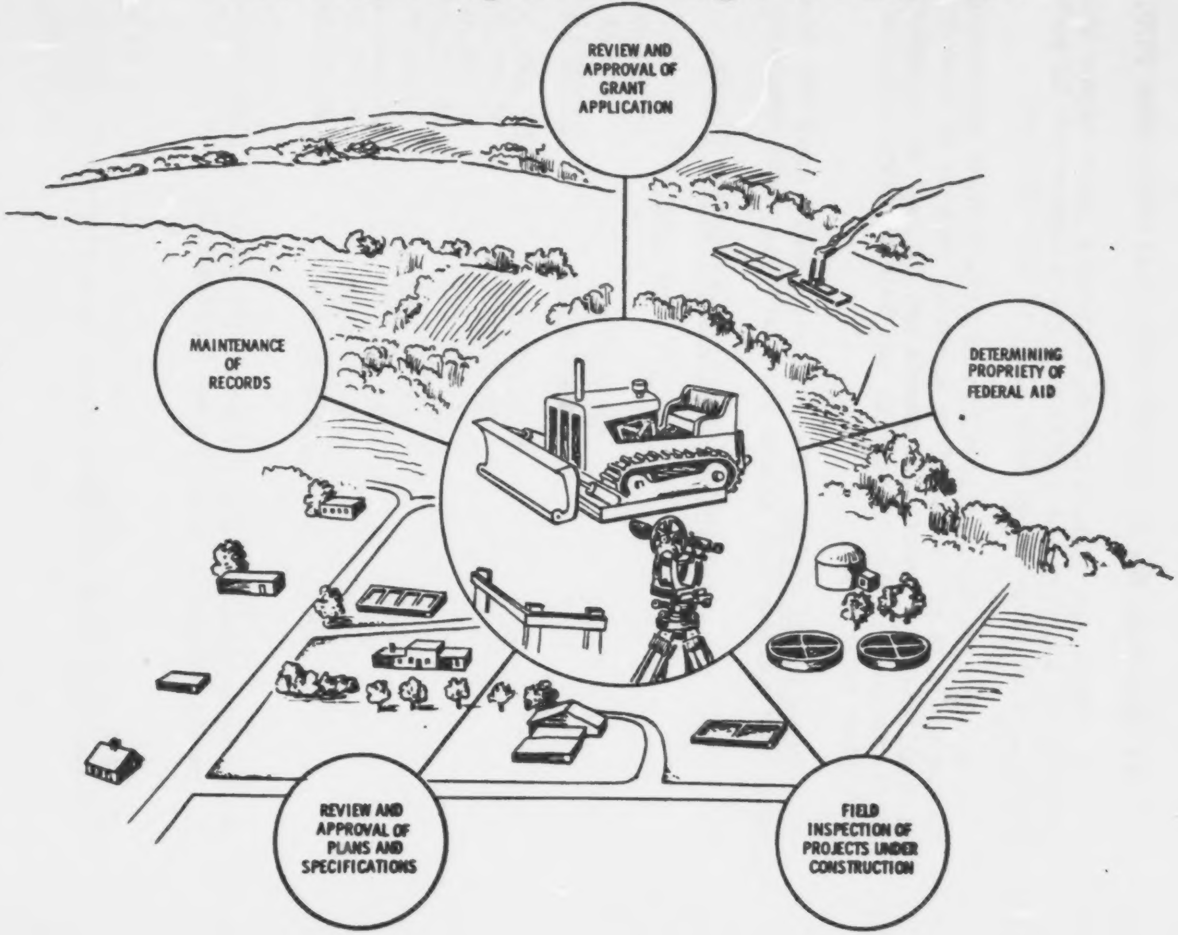
GRANTS FOR CONSTRUCTION OF MUNICIPAL WASTE TREATMENT WORKS

The Federal grants program for municipal waste treatment works was authorized by Public Law 660 in 1956. Prior to this action by the 84th Congress, construction of pollution abatement facilities had fallen well below the level necessary to provide for our expanding population and to replace the aging facilities of an earlier era.

The 1956 Act authorized annual appropriations of $50 million for grants of 30 percent of the cost of sewage treatment works, up to a maximum grant of $250,000 for a single project. The statutory formula for allocation to the States was based upon population and per capita income. Since there was no provision for reallocation of unused State allotments to other States with unmet needs, Congress authorized allocation on the basis of $50 million, but appropriated only $45 million beyond the first year until the Act was amended in 1961. This, in association with supplemental appropriations, had the effect of bringing the full benefits of a $50 million annual appropriation to all States requiring it.

While the 1956 Act had a very salutary effect on the abatement of pollution from municipal wastes, it did not go far enough in certain respects. Construction had sharply increased, but not enough. The grant limitation was too low to attract larger projects and there was no incentive for communities to join together for the construction of multi-municipal treatment facilities. The statutory formula for the allocation of funds among the States did not take into account the differing water pollution control needs and a fund balancing mechanism was desirable.

CONSTRUCTION GRANTS
For Municipal Sewage Treatment


REVIEW AND APPROVAL OF GRANT APPLICATION
MAINTENANCE OF RECORDS
DETERMINING PROPRIETY OF FEDERAL AID
REVIEW AND APPROVAL OF PLANS AND SPECIFICATIONS
FIELD INSPECTION OF PROJECTS UNDER CONSTRUCTION

PHS RESPONSIBILITIES IN THE STATE-FEDERAL ADMINISTRATION OF THE PROGRAM

In 1961, the Congress amended the Federal Water Pollution Control Act to:

1. Authorize annual increased appropriations to $80 million in F. Y. 1962, $90 million in F.Y. 1963, and $100 million for the fiscal years 1964 through 1967.

2. Increase the 30 percent grant limitation from $250,000 to $600,000.

3. Encourage communities to construct joint rather than separate projects by applying the individual grant limitation to each community's share of such projects up to a total of $2.4 million.

4. Require the reallocation of unused State allotments to States having projects which cannot be approved because of lack of funds. Prior to reallocation, additional grants may be made to uncompleted projects where the need is due in part to any Federal institution of Federal construction activity.

Funds Appropriated - The following table shows the annual appropriations for construction grants for municipal waste treatment works.

Appropriations for Construction Grants

FY 1957 - FY 1964

Fiscal Year	Authorized Appropriation	Amount Appropriated
1957	$ 50,000,000	$50,000,000
1958	50,000,000	45,657,000
1959	50,000,000	46,816,000
1960	50,000,000	46,101,000
1961	50,000,000	45,645,000
1962	80,000,000	80,000,000
1963	90,000,000	90,000,000
1964	100,000,000	90,000,000*

* To be allotted to the States on the basis of $100,000,000 and to remain available only through December 31, 1964.

Funds Allocated to States - The annual appropriations of construction grants funds were allocated among the States as follows:

Allocations to States

Construction Grants for Municipal Waste Treatment Works

State	Total F.Y. 1957 - 1962	F.Y. 1963	F.Y. 1964
TOTALS	$330,000,000	$90,000,000	$100,000,000 *
Alabama	7,518,431	1,905,615	2,117,500
Alaska	2,709,560	656,460	730,500
Arizona	3,927,612	1,126,035	1,242,450
Arkansas	6,712,795	1,642,680	1,789,450
California	14,520,772	4,477,410	4,976,200
Colorado	4,198,260	1,138,545	1,255,650
Connecticut	4,231,079	1,183,950	1,325,300
Delaware	2,274,250	639,450	717,700
District of Columbia	2,940,348	728,055	801,550
Florida	6,434,253	2,027,385	2,268,000
Georgia	7,545,969	1,980,045	2,192,000
Hawaii	3,365,515	890,640	954,700
Idaho	3,851,858	1,037,025	1,178,600
Illinois	11,699,138	3,105,180	3,450,800
Indiana	6,982,783	1,897,065	2,102,750
Iowa	5,820,368	1,471,950	1,631,150
Kansas	5,010,757	1,309,410	1,461,650
Kentucky	7,058,778	1,784,070	1,977,900
Louisiana	6,604,531	1,781,820	1,998,400
Maine	4,218,492	1,094,040	1,235,700
Maryland	5,136,852	1,436,715	1,593,900
Massachusetts	7,441,262	1,911,510	2,123,850
Michigan	9,481,391	2,627,325	2,932,300
Minnesota	6,188,107	1,624,545	1,799,400
Mississippi	7,576,580	1,907,010	2,102,400
Missouri	7,025,194	1,796,220	1,995,100
Montana	3,387,075	941,040	1,080,150
Nebraska	4,376,620	1,117,620	1,235,850
Nevada	2,318,451	642,060	702,400
New Hampshire	3,480,450	934,785	1,026,900

State	Total F.Y. 1957 - 1962	F.Y. 1963	Estimated F.Y. 1964
New Jersey	$ 7,556,992	$ 2,102,175	$ 2,338,600
New Mexico	4,063,885	1,105,335	1,243,550
New York	18,222,365	4,731,930	5,255,250
North Carolina	8,421,364	2,163,960	2,388,850
North Dakota	3,767,914	1,089,180	1,267,600
Ohio	11,205,374	3,089,250	3,437,850
Oklahoma	5,687,648	1,442,430	1,609,550
Oregon	4,393,803	1,152,585	1,282,900
Pennsylvania	13,826,075	3,507,255	3,908,250
Rhode Island	3,505,773	938,160	1,046,950
South Carolina	6,660,225	1,759,590	1,945,000
South Dakota	4,212,060	1,095,570	1,205,150
Tennessee	7,463,918	1,920,555	2,129,250
Texas	11,609,968	3,191,355	3,549,900
Utah	3,901,170	1,062,990	1,169,750
Vermont	3,638,530	963,990	1,063,900
Virginia	6,882,240	1,852,920	2,051,950
Washington	5,142,654	1,399,365	1,553,400
West Virginia	5,758,677	1,412,100	1,580,450
Wisconsin	6,532,095	1,719,000	1,911,050
Wyoming	2,408,254	775,080	877,300
Guam	---	1,384,380	1,521,700
Puerto Rico	6,997,260	1,949,445	2,149,550
Virgin Islands	4,104,225	1,375,740	1,512,100

* $90 million appropriated but State allotments based on $100 million in accordance with appropriation act.

Accelerated Public Works Program for Construction for Waste Treatment Works - In 1962 the Congress passed the Public Works Acceleration Act (PL 87-658) which provided for grants for construction of needed public works in areas of substantial unemployment as determined by the Secretary of Labor and in areas designated as redevelopment areas by the Secretary of Commerce. Of the $850 million appropriated for this purpose, $108.9 million was allotted to D/WS&PC for construction of waste treatment works. Grants under this program may represent as much as 75 percent of the cost of the project with no dollar limitation.

Status of Grant Program and Construction Projects - A total of 5,293 projects have been approved for grants of $533 million since 1956. Local communities have contributed $2,049 million of additional funds to meet the total project cost of $2.6 billion. This is a ratio of five local dollars to one Federal dollar in grants-in-aid. Program and project status are shown by the figure and table that follows:

Table 1 - Cumulative Summary of WPC, APW-WPC, and APW
Projects Approved by State and Status of Construction

As of December 31, 1963

Projects:	Approved			Under Construction			Completed		
State	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers
UNITED STATES									
WPC	4584	$1,803,873,539	$412,067,654	931	$646,169,517	$122,337,180	3011	$895,924,620	$220,792,460
APW-WPC	229	101,961,245		136	81,077,049		29	3,566,239	
WPC			21,511,118			16,961,800			718,821
APW			28,440,275			22,839,237			1,037,346
APW	480	141,258,323	70,596,181	199	83,519,958	40,389,885	32	3,091,635	1,490,764
TOTALS	5293	$2,047,093,107	$532,615,228	1266	$810,766,524	$202,528,102	3072	$902,582,494	$224,039,391
ALABAMA									
WPC	72	$ 35,648,813	$ 8,643,418	15	$ 7,673,593	$ 1,969,411	51	$ 25,213,577	$ 5,844,915
APW-WPC	11	8,206,285		6	7,330,385		3	451,300	
WPC			1,620,784			1,358,014			135,390
APW			2,481,558			2,306,378			90,260
APW	11	3,778,470	1,901,990	3	761,050	380,525	--	---	---
Totals	94	47,633,568	14,647,750	24	15,765,028	6,014,328	54	25,664,877	6,070,565
ALASKA									
WPC	9	2,668,050	699,430	2	1,498,778	332,660	2	188,043	56,400
APW-WPC	4	815,907		2	600,000		--	---	
WPC			241,160			180,000			---
APW			262,570			170,000			---
APW	--	---	---	--	---	---	--	---	---
Totals	13	3,483,957	1,203,160	4	2,098,778	682,660	2	188,043	56,400
ARIZONA									
WPC	49	26,234,934	5,636,153	7	12,668,931	1,989,460	38	11,664,760	3,076,333
APW-WPC	--	---		--	---		--	---	
WPC			---			---			---
APW			---			---			---
APW	--	---	---	--	---	---	--	---	---
Totals	49	26,234,934	5,636,153	7	12,668,931	1,989,460	38	11,664,760	3,076,333

Projects:	Approved			Under Construction			Completed		
State	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers
ARKANSAS									
WPC	124	$ 27,280,362	$ 7,021,588	25	$ 8,210,406	$ 2,340,431	89	$ 16,035,535	$ 3,816,262
APW-WPC	25	5,002,192		7	1,659,200		5	499,024	
WPC			1,316,378			417,004			129,917
APW			1,159,377			219,853			116,942
APW	9	680,900	340,450	--	---	---	--	---	---
Totals	158	32,963,454	9,837,793	32	9,869,606	2,977,288	94	16,534,559	4,063,121
CALIFORNIA									
WPC	141	142,256,353	20,409,173	29	92,879,342	7,812,682	105	45,509,271	11,474,721
APW-WPC	--	---		--	---		--	---	
WPC			---			---			---
APW			---			---			---
APW	14	4,513,567	2,233,775	8	3,619,837	1,787,865	6	892,726	446,360
Totals	155	146,769,920	22,642,948	37	96,499,179	9,600,547	111	46,401,997	11,921,081
COLORADO									
WPC	83	20,724,054	6,086,093	12	4,908,339	1,472,492	67	14,684,215	4,274,162
APW-WPC	--	---		--	---		--	---	
WPC			---			---			---
APW			---			---			---
APW	--	---	---	--	---	---	--	---	---
Totals	83	20,724,054	6,086,093	12	4,908,339	1,472,492	67	14,684,215	4,274,162
CONNECTICUT									
WPC	31	22,823,758	5,330,726	10	5,548,690	1,249,736	16	13,722,168	3,148,711
APW-WPC	1	482,400		1	482,400		--	---	
WPC			144,720			144,720			---
APW			96,480			96,480			---
APW	1	392,400	196,200	1	392,400	196,200	--	---	---
Totals	33	23,698,558	5,768,126	12	6,423,490	1,687,136	16	13,722,168	3,148,711
DELAWARE									
WPC	18	7,904,991	2,363,520	5	3,198,076	952,845	12	4,083,525	1,223,657
APW-WPC	4	1,407,800		2	502,200		--	---	
WPC			409,212			137,532			---
APW			294,688			113,568			---
APW	--	---	---	--	---	---	--	---	---
Totals	22	9,312,791	3,067,420	7	3,700,276	1,203,945	12	4,083,525	1,223,657

Projects:	Approved			Under Construction			Completed		
State	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers
DIST. OF COLUMBIA									
WPC	14	$ 26,907,431	$ 3,712,229	7	$ 15,636,435	$ 2,406,962	7	$ 11,270,996	$ 1,305,267
APW-WPC	--	---		--	---		--	---	
WPC			---			---			---
APW			---			---			---
APW	--	---	---	--	---	---	--	---	---
Totals	14	26,907,431	3,712,229	7	15,636,435	2,406,962	7	11,270,996	1,305,267
FLORIDA									
WPC	70	32,744,391	8,643,039	16	10,599,629	2,710,792	48	19,881,408	5,366,113
APW-WPC	--	---		--	---		--	---	
WPC			---			---			---
APW			---			---			---
APW	2	401,500	200,750	1	271,500	135,750	--	---	---
Totals	72	33,145,891	8,843,789	17	10,871,129	2,846,542	48	19,881,408	5,366,113
GEORGIA									
WPC	76	47,646,650	11,288,034	22	21,505,021	4,834,523	40	18,769,820	4,433,156
APW-WPC	--	---		--	---		--	---	
WPC			---			---			---
APW			---			---			---
APW	18	3,291,410	1,654,355	3	665,800	332,900	1	96,532	48,266
Totals	94	50,938,060	12,942,389	25	22,170,821	5,167,423	41	18,866,352	4,481,422
HAWAII									
WPC	23	20,752,565	3,595,710	11	13,386,546	2,024,100	9	3,050,940	850,200
APW-WPC	1	5,500,000		1	5,500,000		--	---	
WPC			600,000			600,000			---
APW			2,150,000			2,150,000			---
APW	--	---	---	--	---	---	--	---	---
Totals	24	26,252,565	6,345,710	12	18,886,546	4,774,100	9	3,050,940	850,200
IDAHO									
WPC	60	16,682,998	4,561,582	8	2,169,613	650,884	36	10,518,595	2,712,400
APW-WPC	4	521,881		2	350,520		1	35,061	
WPC			156,564			105,156			10,518
APW			119,268			86,058			5,950
APW	--	---	---	--	---	---	--	---	---
Totals	64	17,204,879	4,837,414	10	2,520,133	842,098	37	10,553,656	2,728,868

Projects:	Approved			Under Construction			Completed		
State	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers
ILLINOIS									
WPC	192	$ 61,577,160	$ 17,416,481	46	$ 16,511,617	$ 4,857,091	121	$ 31,850,318	$ 8,958,746
APW-WPC	6	996,820		6	996,820		--	---	
WPC			294,286			294,286			---
APW			197,250			197,250			---
APW	40	4,223,635	2,072,228	14	2,486,898	1,180,180	6	390,637	195,318
Totals	238	66,797,615	19,980,245	66	19,995,335	6,528,807	127	32,240,955	9,154,064
INDIANA									
WPC	88	47,072,424	10,736,261	21	16,976,574	2,983,362	50	21,315,336	5,546,808
APW-WPC	--	---		--	---		--	---	
WPC			---			---			---
APW			---			---			---
APW	16	2,734,920	1,363,685	9	2,122,320	1,057,385	--	---	---
Totals	104	49,807,344	12,099,946	30	19,098,894	4,040,747	50	21,315,336	5,546,808
IOWA									
WPC	118	37,913,623	8,085,467	26	15,308,248	2,224,835	75	17,172,245	4,240,778
APW-WPC	--	---		--	---		--	---	
WPC			---			---			---
APW			---			---			---
APW	--	---	---	--	---	---	--	---	---
Totals	118	37,913,623	8,085,467	26	15,308,248	2,224,835	75	17,172,245	4,240,778
KANSAS									
WPC	146	24,764,223	6,857,825	17	3,119,601	929,244	114	17,564,393	4,809,701
APW-WPC	--	---		--	---		--	---	
WPC			---			---			---
APW			---			---			---
APW	3	145,400	72,700	2	96,900	48,450	1	48,500	24,250
Totals	149	24,909,623	6,930,525	19	3,216,501	977,694	115	17,612,893	4,833,951
KENTUCKY									
WPC	73	29,989,482	7,428,310	17	7,452,660	1,542,881	44	16,097,132	4,122,783
APW-WPC	27	9,940,419		20	8,520,738		--	---	
WPC			1,864,719			1,653,235			---
APW			3,447,229			2,897,963			---
APW	40	10,154,884	5,737,457	7	2,081,000	1,007,570	--	---	---
Totals	140	50,084,785	18,477,715	44	18,054,398	7,101,649	44	16,097,132	4,122,783

Projects:	Approved			Under Construction			Completed		
State	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers
LOUISIANA									
WPC	75	$ 30,949,491	$ 8,535,017	14	$ 8,128,460	$ 1,824,419	56	$ 19,061,878	$ 5,505,621
APW-WPC	8	6,028,796		7	4,263,358		1	341,000	
WPC			820,208			806,408			13,800
APW			1,452,001			1,304,501			147,500
APW	22	18,430,149	8,287,445	17	15,896,571	7,397,275	1	23,600	11,800
Totals	105	55,408,436	19,094,671	38	28,288,389	11,332,603	58	19,426,478	5,678,721
MAINE									
WPC	17	7,906,389	2,351,073	2	1,290,280	387,084	11	4,246,671	1,254,493
APW-WPC	7	4,497,919		6	2,875,919		--	---	
WPC			1,349,370			862,770			---
APW			859,280			534,880			---
APW	--	---	---	--	---	---	--	---	---
Totals	24	12,404,308	4,559,723	8	4,166,199	1,784,734	11	4,246,671	1,254,493
MARYLAND									
WPC	73	28,396,189	6,688,358	18	8,020,364	2,027,108	38	14,741,289	3,293,685
APW-WPC	4	1,728,800		2	632,200		--	---	
WPC			432,175			158,025			---
APW			432,175			158,025			---
APW	1	435,700	217,850	--	---	---	--	---	---
Totals	78	30,560,689	7,770,558	20	8,652,564	2,343,158	38	14,741,289	3,293,685
MASSACHUSETTS									
WPC	86	34,908,222	8,688,805	28	15,446,573	4,095,887	50	14,527,249	3,754,477
APW-WPC	4	6,608,820		4	6,608,820		--	---	
WPC			884,691			884,691			---
APW			2,419,718			2,419,718			---
APW	5	2,720,600	1,355,300	4	2,093,800	1,041,900	--	---	---
Totals	95	44,237,642	13,348,514	36	24,149,193	8,442,196	50	14,527,249	3,754,477
MICHIGAN									
WPC	80	54,761,430	10,914,001	18	29,314,997	4,429,972	61	25,119,433	6,385,929
APW-WPC	2	6,784,788		1	6,200,640		1	584,148	
WPC			1,385,203			1,366,539			18,664
APW			1,651,081			1,377,671			273,410
APW	30	10,502,233	5,248,057	21	9,358,681	4,676,287	2	226,252	113,120
Totals	112	72,048,451	19,198,342	40	44,874,318	11,850,469	64	25,929,833	6,791,123

Projects:	Approved			Under Construction			Completed		
State	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers
MINNESOTA									
WPC	108	$ 29,163,301	$ 8,230,523	24	$ 7,603,226	$ 2,074,255	63	$ 17,878,015	$ 5,056,520
APW-WPC	--	---		--	---		--	---	
WPC			---			---			---
APW			---			---			---
APW	18	1,619,639	795,763	11	1,259,511	582,450	3	115,400	48,950
Totals	126	30,782,940	9,026,286	35	8,862,737	2,656,705	66	17,993,415	5,105,470
MISSISSIPPI									
WPC	129	27,281,144	7,674,845	13	2,713,334	797,296	74	13,888,856	3,767,225
APW-WPC	9	2,138,677		2	1,273,910		2	234,000	
WPC			641,600			382,170			73,655
APW			386,804			211,882			43,392
APW	--	---	---	--	---	---	--	---	---
Totals	138	29,419,821	8,703,249	15	3,987,244	1,391,348	76	14,122,856	3,884,272
MISSOURI									
WPC	148	43,915,568	10,526,823	18	17,710,299	3,286,110	119	19,093,779	5,387,889
APW-WPC	--	---		--	---		--	---	
WPC			---			---			---
APW			---			---			---
APW	22	3,256,278	1,622,882	9	2,461,965	1,230,981	3	323,264	156,385
Totals	170	47,171,846	12,149,705	27	20,172,264	4,517,091	122	19,417,043	5,544,274
MONTANA									
WPC	74	13,892,218	3,819,412	8	2,136,549	640,965	54	9,084,693	2,489,403
APW-WPC	1	192,000		1	192,000		--	---	
WPC			57,600			57,600			---
APW			38,400			38,400			---
APW	--	---	---	--	---	---	--	---	---
Totals	75	14,084,218	3,915,412	9	2,328,549	736,965	54	9,084,693	2,489,403
NEBRASKA									
WPC	167	38,285,198	6,048,129	21	20,114,975	1,668,302	111	14,167,011	3,182,451
APW-WPC	9	440,059		3	200,400		4	203,492	
WPC			124,618			59,782			53,479
APW			93,200			39,308			46,321
APW	--	---	---	--	---	---	--	---	---
Totals	176	38,725,257	6,265,947	24	20,315,375	1,767,392	115	14,370,503	3,282,251

Project:	Approved			Under Construction			Completed		
State	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers
NEVADA									
WPC	36	$ 11,337,557	$ 2,882,844	7	$ 1,969,028	$ 564,350	27	$ 5,476,429	$ 1,637,434
APW-WPC	--	---		--	---		--	---	
WPC			---			---			---
APW			---			---			---
APW	--	---	---	--	---	---	--	---	---
Totals	36	11,337,557	2,882,844	7	1,969,028	564,350	27	5,476,429	1,637,434
NEW HAMPSHIRE									
WPC	31	12,735,196	3,771,225	9	4,705,667	1,437,357	17	4,169,979	1,195,652
APW-WPC	4	2,968,100		3	2,648,100		--	---	
WPC			829,210			763,450			---
APW			624,600			560,600			---
APW	--	---	---	--	---	---	--	---	---
Totals	35	15,703,296	5,225,035	12	7,353,767	2,761,407	17	4,169,979	1,195,652
NEW JERSEY									
WPC	74	50,879,917	10,902,099	24	19,258,199	4,140,150	39	23,473,237	5,004,249
APW-WPC	5	2,186,900		5	2,186,900		--	---	
WPC			453,845			453,845			---
APW			531,145			531,145			---
APW	13	11,008,470	5,504,235	9	8,464,470	4,232,235	--	---	---
Totals	92	64,075,287	17,391,324	38	29,909,569	9,357,375	39	23,473,237	5,004,249
NEW MEXICO									
WPC	57	18,454,701	4,904,970	7	3,701,269	1,178,254	47	14,188,657	3,625,357
APW-WPC	14	1,412,819		3	331,400		5	606,274	
WPC			401,457			99,420			159,511
APW			289,503			54,843			151,337
APW	--	---	---	--	---	---	--	---	---
Totals	71	19,867,520	5,595,930	10	4,032,669	1,332,517	52	14,794,931	3,936,205
NEW YORK									
WPC	170	143,714,457	25,446,161	56	64,266,037	9,927,972	96	54,785,945	9,792,332
APW-WPC	3	874,607		1	154,215		1	94,292	
WPC			219,019			46,265			17,390
APW			218,285			30,843			29,756
APW	12	8,124,600	4,062,300	5	6,524,000	3,262,000	--	---	---
Totals	185	152,713,664	29,945,765	62	70,944,252	13,267,080	97	54,880,237	9,839,478

Projects:	Approved			Under Construction			Completed		
State	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers
NORTH CAROLINA									
WPC	111	$ 48,240,924	$ 12,063,098	21	$ 12,435,140	$ 3,212,661	66	$ 27,328,575	$ 6,585,855
APW-WPC	3	1,599,690		2	885,690		--	---	
WPC			355,612			228,840			---
APW			438,454			208,226			---
APW	35	9,875,671	4,925,439	7	1,436,684	687,042	2	538,093	233,200
Totals	149	59,716,285	17,782,603	30	14,757,514	4,336,769	68	27,866,668	6,819,055
NORTH DAKOTA									
WPC	134	12,182,977	3,532,737	8	1,168,546	349,644	110	10,185,108	2,935,575
APW-WPC	--	---		--	---		--	---	
WPC			---			---			---
APW			---			---			---
APW	--	---	---	--	---	---	--	---	---
Totals	134	12,182,977	3,532,737	8	1,168,546	349,644	110	10,185,108	2,935,575
OHIO									
WPC	136	75,603,370	16,696,782	35	23,426,824	4,873,346	88	39,886,994	9,226,866
APW-WPC	1	1,888,959		1	1,985,000		--	---	
WPC			201,979			201,979			---
APW			742,500			742,500			---
APW	13	2,619,400	1,345,380	2	693,000	346,500	--	---	---
Totals	150	80,111,729	18,986,641	38	26,104,824	6,164,325	88	39,886,994	9,226,866
OKLAHOMA									
WPC	177	28,939,085	8,199,633	35	7,963,515	2,380,167	124	17,872,037	4,812,730
APW-WPC	8	957,836		5	607,288		2	253,548	
WPC			130,034			86,400			42,234
APW			332,820			215,080			84,540
APW	19	2,268,457	1,134,228	9	843,600	421,800	1	55,277	27,638
Totals	204	32,165,378	9,796,715	49	9,414,403	3,103,447	127	18,180,862	4,967,142
OREGON									
WPC	85	26,653,646	6,632,065	18	9,718,407	2,150,452	57	15,294,288	4,116,485
APW-WPC	2	138,178		2	138,178		--	---	
WPC			24,010			24,010			---
APW			41,980			41,980			---
APW	7	1,545,300	772,650	5	1,029,300	514,650	--	---	---
Totals	94	28,337,124	7,470,705	25	10,885,885	2,731,092	57	15,294,288	4,116,485

Projects:	Approved			Under Cosntruction			Completed		
State	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers
PENNSYLVANIA									
WPC	126	$ 86,672,573	$ 19,228,380	36	$ 33,399,970	$ 6,019,659	70	$ 44,013,679	$ 10,144,586
APW-WPC	--	---		--	---		--	---	
WPC			---			---			---
APW			---			---			---
APW	33	16,906,114	8,488,304	19	11,969,840	5,936,967	2	234,774	117,387
Totals	159	103,578,687	27,716,684	55	45,369,810	11,956,626	72	44,248,453	10,261,973
RHODE ISLAND									
WPC	22	5,967,519	1,677,717	3	151,682	45,505	13	3,629,843	1,088,953
APW-WPC	7	12,445,351		7	12,445,351		--	---	
WPC			2,515,300			2,515,300			---
APW			3,455,850			3,455,850			---
APW	1	413,600	206,800	--	---	---	--	---	---
TOTALS	30	18,826,470	7,855,667	10	12,597,033	6,016,655	13	3,629,843	1,088,953
SOUTH CAROLINA									
WPC	85	26,083,146	7,152,951	16	7,332,587	2,127,776	45	10,284,663	2,954,972
APW-WPC	9	2,272,698		6	2,007,398		1	92,000	
WPC			671,138			591,548			27,600
APW			390,367			342,817			12,890
APW	--	---	---	--	---	---	--	---	---
Totals	94	28,355,844	8,214,456	22	9,339,985	3,062,141	46	10,376,663	2,995,462
SOUTH DAKOTA									
WPC	93	11,494,421	3,005,665	8	1,759,111	526,179	71	4,462,725	1,340,710
APW-WPC	--	---		--	---		--	---	
WPC			---			---			---
APW			---			---			---
APW	1	59,200	29,600	--	---	---	--	---	---
Totals	94	11,553,621	3,035,265	8	1,759,111	526,179	71	4,462,725	1,340,710
TENNESSEE									
WPC	81	34,676,354	9,253,360	15	7,882,140	1,723,881	54	21,119,114	5,753,149
APW-WPC	9	2,817,282		7	2,389,282		--	---	
WPC			823,824			855,954			---
APW			557,624			481,224			---
APW	10	1,914,780	1,039,790	4	1,094,660	593,730	--	---	---
Totals	100	39,408,416	11,674,598	26	11,366,082	3,654,789	54	21,119,114	5,753,149

Projects:	Approved			Under Construction			Completed		
State	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers
TEXAS									
WPC	217	$ 72,316,368	$ 17,679,694	50	$ 21,073,492	$ 5,193,092	132	$ 42,548,838	$ 9,763,590
APW-WPC	3	392,988		3	392,988		--	---	
WPC			71,120			71,119			---
APW			125,374			125,374			---
APW	24	4,646,750	2,326,875	6	820,850	410,425	1	33,000	16,500
Totals	244	77,366,106	20,203,063	59	22,287,330	5,800,010	133	42,581,838	9,780,090
UTAH									
WPC	33	24,087,378	4,357,880	7	8,297,117	972,155	25	15,595,561	3,357,325
APW-WPC	1	140,000		1	140,000		--	---	
WPC			27,000			27,000			---
APW			43,000			43,000			---
APW	3	295,000	147,500	1	128,000	64,000	--	---	---
Totals	37	24,522,378	4,575,380	9	8,565,117	1,106,155	25	15,595,561	3,357,325
VERMONT									
WPC	25	14,232,540	4,091,574	6	4,335,150	1,300,545	15	7,648,390	2,116,329
APW-WPC	1	1,506,300		1	1,506,300		--	---	
WPC			387,110			387,110			---
APW			366,040			366,040			---
APW	2	1,588,364	794,182	1	1,529,600	714,182	--	---	---
Totals	28	17,327,204	5,638,906	8	7,371,050	2,767,877	15	7,648,390	2,116,329
VIRGINIA									
WPC	138	41,430,907	8,933,687	30	12,230,271	2,627,910	87	21,963,341	4,699,710
APW-WPC	6	2,111,110		2	830,700		--	---	
WPC			532,141			241,500			---
APW			583,026			145,800			---
APW	6	1,788,100	889,298	2	317,000	132,428	--	---	---
Totals	150	45,330,117	10,938,152	34	13,377,971	3,147,638	87	21,963,341	4,699,710
WASHINGTON									
WPC	102	32,062,828	7,192,542	11	6,204,826	1,261,064	77	21,937,804	4,761,533
APW-WPC	2	72,132		1	55,532		1	16,600	
WPC			8,620			3,660			4,960
APW			30,998			27,690			3,308
APW	11	1,927,000	955,350	9	2,846,520	915,110	1	57,980	28,990
Totals	115	34,061,960	8,187,510	21	9,106,878	2,207,524	79	22,012,384	4,798,791

Projects:	Approved			Under Construction			Completed		
State	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers	No.	Eligible Costs	Federal Grant Offers
WEST VIRGINIA									
WPC	50	$ 23,141,253	$ 6,263,056	12	$ 5,284,143	$ 1,528,321	26	$ 12,786,173	$ 3,321,633
APW-WPC	15	5,126,445		8	3,635,067		1	113,000	
WPC			1,073,788			742,023			26,250
APW			1,440,070			1,021,094			17,500
APW	25	7,812,751	4,017,873	4	1,732,100	849,898	--	---	---
Totals	90	36,080,449	12,794,787	24	10,651,310	4,141,336	27	12,899,173	3,365,383
WISCONSIN									
WPC	171	35,058,975	9,119,005	41	11,258,950	2,629,885	112	19,178,414	5,103,570
APW-WPC	3	335,287		2	295,900		1	42,500	
WPC			84,223			78,770			5,453
APW			75,210			71,971			14,240
APW	12	845,081	409,490	6	522,101	253,200	2	55,600	22,600
Totals	186	36,239,343	9,687,928	49	12,076,951	3,033,826	115	19,276,514	5,145,863
WYOMING									
WPC	48	6,501,769	1,798,627	2	126,553	37,965	42	5,373,246	1,474,163
APW-WPC	4	296,000		3	252,250		--	---	
WPC			88,800			75,675			---
APW			58,200			51,225			---
APW	--	---	---	--	---	---	--	---	---
Totals	52	6,797,769	1,945,627	5	378,803	164,865	42	5,373,246	1,474,163
PUERTO RICO									
WPC	38	20,354,266	5,289,877	14	6,489,737	1,613,101	10	2,320,429	640,896
APW-WPC	2	1,125,000		--	---		--	---	
WPC			269,600			---			---
APW			554,150			---			---
APW	1	328,000	246,000	--	---	---	--	---	---
	41	21,807,266	6,359,627	14	6,489,737	1,613,101	10	2,320,429	640,896
GUAM	--	---	---	--	---	---	--	---	---
VIRGIN ISLANDS	--	---	---	--	---	---	--	---	---

Percent of Funds Used for Treatment Plants or Interceptor and Outfall Sewers - Municipal waste treatment works involve sewage treatment plants, interceptor sewers, outfall sewers, and related pumping stations. Historically, sewage treatment plants have accounted for slightly more than half of total treatment works construction. Under the grants program, 53 percent of the Federal funds has been used in support of sewage treatment plant construction and 47 percent for interceptor and outfall sewer construction. This is shown below in greater detail by States.

Percent of Funds Used for Treatment Plants or Interceptor and Outfall Sewers

States	Percent of Funds: Sewage Treatment Plants	Percent of Funds: Interceptor and Outfall Sewers
TOTALS - U. S.	53	47
Alabama	61	39
Alaska	56	44
Arizona	47	53
Arkansas	38	62
California	40	60
Colorado	65	35
Connecticut	66	34
Delaware	46	54
District of Columbia	40	60
Florida	59	41
Georgia	61	39
Hawaii	52	48
Idaho	42	58
Illinois	65	35
Indiana	71	29
Iowa	61	39
Kansas	85	15
Kentucky	57	43
Louisiana	54	46
Maine	54	46
Maryland	31	69
Massachusetts	35	65
Michigan	59	41
Minnesota	61	39
Mississippi	44	56

States	Percent of Funds Sewage Treatment Plants	 Interceptor and Outfalls Sewers
Missouri	51	49
Montana	47	53
Nebraska	55	45
Nevada	21	79
New Hampshire	44	56
New Jersey	47	53
New Mexico	51	49
New York	56	44
North Carolina	68	32
North Dakota	36	64
Ohio	62	38
Oklahoma	46	54
Oregon	50	50
Pennsylvania	63	37
Rhode Island	50	50
South Carolina	51	49
South Dakota	49	51
Tennessee	65	35
Texas	56	44
Utah	73	27
Vermont	57	43
Virginia	48	52
Washington	44	56
West Virginia	55	45
Wisconsin	42	58
Wyoming	46	54
Puerto Rico	15	85
Virgin Islands	0	0

Operation and Maintenance of Completed Grant Projects - In determining the desirability of financial aid for waste treatment works projects under the Federal Water Pollution Control Act, consideration must be given to the adequacy of the provisions made or proposed by the applicants for assuring proper and efficient operation and maintenance of the treatment works following completion of construction. Initially, this determination was made through an evaluation of funds proposed by the applicants for this purpose. A national survey of municipal waste treatment works operation and maintenance costs for plants constructed prior to the grants program was made to provide the background information required in the evaluation process. This strengthened the application review procedures, but did not contribute to the evaluation of actual operation of Federally-aided projects following completion. Discussions with State Water Pollution

Control Administrators, the review of State Program Plans for Water Pollution Control, and reports of State Water Pollution Control Agencies indicated that many of the State programs do not assure adequate operation of treatment facilities and that increased attention to this problem is required.

A new program was undertaken in 1962 to evaluate the performance of communities in carrying out their assurances concerning the operation and maintenance of completed projects. Visits are being made to all projects by Public Health Service engineers in the company of State representatives wherever the States desire to participate. Discussions involve local officials wherever possible. Copies of the reports are given to the communities and State agencies. Analyses of finding are being provided to Public Health Service regional staffs for follow-up discussions with State regulatory officials. There is no way to assure satisfactory operation of municipal waste treatment works without regulatory agency supervision. The Federal Water Pollution Control Act declares that the primary responsibilities and rights in preventing and controlling water pollution belong to the States. The Federal role pertaining to treatment plant operation is one which attempts to support and strengthen the States in carrying out their primary responsibilities.

Accomplishments in Reducing Pollution

The advent of Federal aid in 1956 under P.L. 660 was accompanied by a 62 percent increase in the dollar volume of waste treatment works construction, with contract awards rising from a previous five-year annual average of $222 million to $360 million under the construction grant program for the years 1956-1961. With the increased assistance provided by the 1961 Amendments, construction again was accelerated with contract awards reaching $449 million in 1961 and $545 million in 1962. Additional assistance under the Accelerated Public Works Act of 1962 further accelerated waste treatment works construction with contract awards reaching $667 million in 1963, according to preliminary estimates. This was an increase of 25 percent in 1961, 51 percent in 1962, and 85 percent in 1963 over the average for the first four years of the program.

In spite of these marked increases, construction of waste treatment works is still below the level necessary to bring the municipal waste pollution problem under control during the current decade. Prior to the grants program, construction failed to keep pace with obsolescence of existing treatment facilities and population growth, or with the backlog of needs which developed during World War II. The initial Federal aid of $50 million per year, made available by Public Law 660, increased construction sufficiently to care for population growth and obsolescence, but had little effect on the backlog. Since enactment of the 1961 Amendments, there has been a decrease in the backlog of treatment facilities needed for sewered communities, but an increase for unsewered communities with the total cost of needed construction remaining constant. The affect of the Accelerated Public Works program cannot be determined accurately at this time since we have no information as to the future of the program. The Nation's municipal waste treatment needs have been reanalyzed and required future construction is reported under the second section of this report.

The 5,293 projects approved as of December 31, 1963, will serve a population of 42 million and will improve the quality of 45,000 miles of streams.

FEDERAL ENFORCEMENT ACTIVITIES

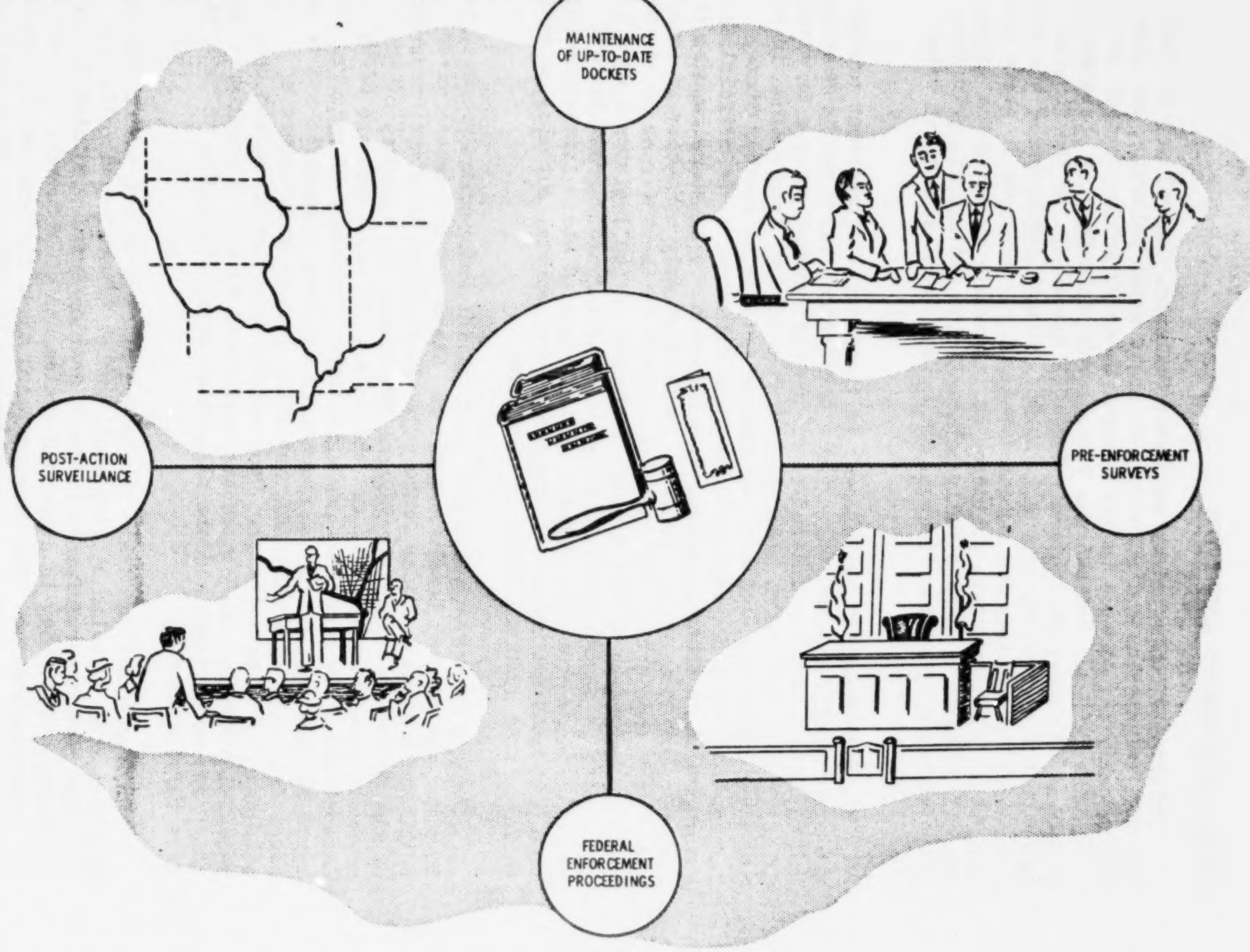
Originally conferred by the Water Pollution Control Act of 1948, Federal jurisdiction and authority to abate water pollution was more specifically established by the Federal Water Pollution Control Act of 1956. The 1956 Act defined the Federal role in enforcing abatement of pollution of interstate waters. The 1961 Amendments to the Federal Water Pollution Control Act, P.L. 87-88, further strengthened the Act's enforcement procedures and extended Federal jurisdiction to abate both interstate and intrastate pollution of interstate or navigable waters. The enforcement provisions fully adhere to the Act's basic principle of providing cooperative Federal, State, and local efforts in water pollution control.

The procedures to be followed in the Federal enforcement process are specifically spelled out: (1) a conference; (2) a public hearing; and (3) court action. Initiation of the enforcement process in situations of interstate pollution, where pollution emanating from sources in one State endangers the health or welfare of persons in another State, is mandatory upon the request of a State Governor, or an official State water pollution control agency, or a municipality in whose request the Governor and State agency concur. It is similarly mandatory in intrastate pollution situations upon the request of the Governor of the State concerned when the effect of such pollution on the legitimate uses of the waters is judged sufficient by the Secretary to warrant Federal action. The exercise of Federal jurisdiction to abate interstate pollution without State request is required when reports, surveys, or studies indicate that such pollution is occurring.

The conference, the initial stage of the enforcement process, brings together the Federal Government and the State and interstate water pollution control agencies concerned. It inquires into the occurrence of the pollution subject to Federal abatement, the adequacy of the measures taken to abate it, and the delays, if any, that are being encountered. The conferees may agree upon a schedule of required remedial measures, or in the absence of adequate scientific and technical data, may agree that further study is necessary before a schedule may be established. Upon establishment of an agreed upon remedial schedule, the States are encouraged to obtain compliance under their own authorities and are allowed at least six months to take the necessary actions.

When such action within the period allowed is not taken, the Act provides that a public hearing shall ensue. The alleged polluters are made direct participants before a Hearing Board appointed by the Secretary. Testimony is sworn and statements of witnesses are subject to cross-examination. The Hearing Board makes findings on the evidence presented and recommends to the Secretary the measures which must be taken to secure abatement. The Board's findings and recommendations are sent by the Secretary to the polluters and to the State agencies, together with a notice specifying a reasonable time, which may not be less than six months, to secure the abatement of the pollution.

FEDERAL ENFORCEMENT
Pollution of Interstate Waters


MAINTENANCE OF UP-TO-DATE DOCKETS
POST-ACTION SURVEILLANCE
PRE-ENFORCEMENT SURVEYS
FEDERAL ENFORCEMENT PROCEEDINGS

Court action, the last stage, may be requested by the Secretary to be brought by the Attorney General when remedial action is not taken by the polluters within the time specified in the notice. In an intrastate pollution matter, the written consent of the Governor is necessary to proceed with the court action.

Funds Appropriated - Appropriations for Federal enforcement programs under P.L. 660 are shown below and these show an increasing support for these activities.

Appropriations for
Federal Enforcement Activities

Fiscal Year	Amount	Fiscal Year	Amount
1957	$250,000	1961	$1,291,000
1958	350,000	1962	2,311,000
1959	368,000	1963	2,915,000
1960	512,000	1964	3,603,000

Enforcement Actions Taken to Date

Twenty-nine enforcement actions have been instituted to date. Sixteen have been taken upon Federal initiative as provided for under the Federal Water Pollution Control Act. Thirteen have been taken upon requests by the States, including three involving intrastate pollution situations where Federal assistance was requested by the Governors of Michigan and Washington. Of these 29 actions, four have progressed to the public hearing stage and only one was brought to court action. This record attests to the effectiveness of the conference stage in securing agreements on pollution situations and schedules for remedial actions.

Actions Taken on Federal Initiative - The sixteen enforcement actions taken upon Federal initiative involved the following interstate water pollution situations:

1. Corney Drainage System, 1954 (Arkansas - Louisana)
2. Big Blue River, 1957 (Nebraska - Kansas)
3. Missouri River in the St. Joseph, Missouri, Area, 1957 (Missouri - Kansas)
4. Missouri River in the Omaha, Nebraska, Area, 1957 (Nebraska - Kansas - Missouri - Iowa)
5. Potomac River in the Washington Metropolitan Area, 1957 (District of Columbia - Maryland - Virginia)
6. Missouri River in the Kansas Cities Metropolitan Area, 1957 (Kansas - Missouri)
7. Lower Columbia River, 1958 (Washington - Oregon)
8. Raritan Bay, 1961 (New York - New Jersey)
9. Mississippi River, Clinton, Iowa, Area, 1962 (Illinois - Iowa)

10. Androscoggin River, 1962 (New Hampshire - Maine)
11. Coosa River, 1963 (Alabama - Georgia)
12. Pearl River, 1963 (Louisiana - Mississippi)
13. Menominee River, 1963 (Michigan - Wisconsin)
14. Lower Connecticut River, 1963 (Massachusetts - Connecticut)
15. Monongahela River, 1963 (West Virginia - Maryland - Pennsylvania)
16. Snake River, Lewiston-Clarkston Area, 1963 (Idaho - Washington)

Actions Taken at State Request - The thirteen interstate enforcement actions that have been initiated at the request of State water pollution control agencies or Governors and the three intrastate actions initiated on request of Governors are:

1. Missouri River in the Sioux City Area, 1958 (South Dakota - Iowa - Nebraska - Missouri - Kansas)
2. Mississippi River in the St. Louis Metropolitan Area, 1958 (Missouri - Illinois)
3. Animas River, 1958 (Colorado -New Mexico)
4. Bear River, 1960 (Idaho - Wyoming - Utah)
5. Colorado River and All Tributaries, 1960 (Colorado - Utah - Arizona - Nevada - California - New Mexico - Wyoming)
6. Holston River, North Fork, 1960 (Tennesseee- Virginia)
7. North Platte River, 1962 (Nebraska - Wyoming)
8. Puget Sound-Upper Columbia River, 1962 (Washington) (Requested by Governor)
9. Detroit River, 1962 (Michigan) (Requested by Governor)
10. Escambia River, 1962 (Alabama - Florida)
11. South Platte River, 1963 (Colorado) (Requested by Governor)
12. Upper Mississippi River, 1963 (Minnesota - Wisconsin)
13. Merrimack-Nashua River, 1963 (New Hampshire - Massachusetts)

Status of Enforcement Actions

Once an enforcement action determines that the interstate or intrastate pollution referred to is affecting health or welfare, it is often necessary to proceed with field surveys and studies, sometimes extensive, to provide data on which to determine the most appropriate remedial measures and a schedule for their completion. When the remedial schedule has been agreed to, it is next necessary to see that it is adhered to. Even after the remedial measures have been placed in effect, there is a responsibility to maintain sufficient surveillance to assure that they are properly operated and maintained in protecting the health or welfare originally affected by the pollution situation. Since the Federal enforcement program covers a relatively few years, the actions that have been taken are in various stages of study, remedial action, and/or surveillance:

1. Corney Drainage System (Arkansas - Louisiana)

This enforcement action was held under the Water Pollution Control Act of June 30, 1948. On June 9, 1954, the Surgeon General found that oil well discharges originating in Arkansas were endangering the welfare of persons in Louisiana by causing the pollution of the Corney Drainage System. This pollution was primarily brine from some 75 oil wells, all privately owned.

A public hearing was held on the matter of pollution of the interstate waters of the Corney Drainage System on January 16-17, 1957, at Homer, Louisiana. On the basis of evidence presented, the hearing board required that polluters of the Corney Drainage System cease and desist from discharging substances which contribute to the pollution within 90 days of receipt of the board's recommendations.

As of 1960 the unsatisfactory brine pits had been replaced and abatement is being accomplished by injection systems. According to available information these systems are working satisfactorily and the polluters (owners of wells) are in full compliance. The Arkansas Water Pollution Control Commission and the U.S. Public Health Service keep constant surveillance on the area to see that proper operation reinjection systems is maintained.

2. Big Blue River (Nebraska - Kansas)

A conference was held on May 3, 1957, at Beatrice, Nebraska. Eleven municipalities and one institution in the States of Kansas and Nebraska were involved. Remedial action adopted and complied with by the conferees involved construction of new facilities and additions and modifications to existing facilities, as well as programs of improved operation and maintenance. Over $1.8 million was expended in the construction of waste treatment facilities, with Federal grants of $491,973. Cities involved included Beatrice, Friend, Milford, Hastings, and Wilbur, Nebraska. A study has been proposed to determmne the effectiveness of the treatment now provided for the discharges entering the Big Blue River.

3. Missouri River, St. Joseph, Missouri Area (Missouri - Kansas)

A conference was held at St. Joseph, Missouri on June 11, 1957, on the pollution situation caused by the discharges of untreated sewage and industrial wastes by St. Joseph, Missouri and its associated stockyard area. Involved in the conference were 8 municipalities, 4 institutions, and 18 industries.

Failure to abide by the schedule necessitated the calling of a public hearing by the Secretary of the Department of Health, Education, and Welfare on the city of St. Joseph and 18 industries, which was held on July 27-30, 1959. Subsequently, in view of continued failure to comply, suit was filed by the United States against the City of St. Joseph in the Federal District Court at St. Joseph, Missouri, September 29, 1960. The court issued an order on October 31. 1961, substantially embodying the Hearing Board's recommendations.

Condemnation proceedings have begun on land needed for construction of the main sewer treatment plant at St. Joseph. Three million dollars in revenue bonds have been sold to pay for this construction. Industries involved plan discharge to industrial district or municipal plants. The court has retained jurisdiction over compliance in this case.

4. Missouri River, Omaha, Nebraska Area (Nebraska - Kansas - Missouri - Iowa)

The conference was held on June 14, 1957, at Omaha, Nebraska. The conferees found that the major source of the pollution was Omaha, Nebraska. Fourteen municipalities, four sewer districts, two institutions and five industries were involved. A remedial time schedule was recommended by the conferees and Omaha now has a 21 million dollar program nearing completion. South Omaha also has a $5.2 million project under construction. Council Bluffs, Iowa, has also completed construction of a sewage treatment plant at a cost of $1.75 million. Industries concerned are planning connections to a municipal system.

5. Potomac River, Washington Metropolitan Area (District of Columbia - Maryland - Virginia)

The first session of the conference was held on August 22, 1957 at Charlottesville, Virginia and a second session was held on February 13, 1958, at Washington, D. C. Untreated and inadequately treated sewage from Alexandria, Virginia, Arlington and Fairfax Counties, Virginia, and the District of Columbia contributed to pollution of the river.

The conferees at the second session established time schedules for remedial measures. Implementation of the time schedule is proceeding and substantial improvements have been made. Secondary treatment facilities at the Blue Plains treatment plant for Washington, D. C. were placed in operation in July 1959. Further improvements are now proceeding. Virginia and Maryland communities are also complying with the time schedule for construction of abatement facilities. Industrial waste has not been a significant problem in the Washington, D. C. area.

6. Missouri River, Kansas Cities Metropolitan Area (Kansas - Missouri)

The conference was held at Kansas City, Missouri on December 3, 1957. Principal sources of pollution were discharges of untreated and inadequately treated sewage and industrial wastes involving 22 municipalities, 3 subdivisions, 3 institutions, 2 sewer districts, and 33 industries. A schedule of remedial measures to be instituted by the two Kansas Cities and North Kansas City and their associated industries was recommended by the conferees.

When effective progress was not obtained in accordance with the schedule of remedial measures the Secretary of Health, Education, and Welfare called a public hearing on Kansas City, Kansas, Kansas City, Missouri, North Kansas City, Missouri, Fairfax Drainage District of Kansas and 11 industries. The hearing was held June 13-17, 1960 at Kansas City, Missouri.

Substantial progress has been made in the Kansas Cities Metropolitan Area. Financing has been provided for the construction of pollution abatement facilities by Kansas City, Kansas in the amount of $15,000,000; North Kansas City, Missouri, $7,443,000; and Kansas City, Missouri, $75,000,000. Two industries involved, Phillips Petroleum Company and Sinclair Refining Company are providing their own separate treatment. Other industries, including Proctor & Gamble, General Motors, and Swift and Company, will be served by the municipal system.

7. Mississippi River, St. Louis Metropolitan Area (Missouri - Illinois)

A conference was held March 4, 1958, at St. Louis, Missouri, involving St. Louis, 22 other sewer districts in Missouri, and 23 communities, 17 industries, and an institution in Illinois. The conferees established a time schedule for remedial action. In November of 1962 St. Louis voted a 95 million dollar bond issue for the construction of treatment facilities and action has or is being taken to abate pollution from the Illinois sources. Reports indicate all communities will have initiated construction activity in 1963. Some industries, including Shell Oil Company, Standard Oil Company, United Starch and Refining, and Sinclair Oil and Refining, now provide adequate treatment. Seven progress meetings have been held to coordinate pollution abatement programs in the area.

8. Animas River (Colorado - New Mexico)

The first session of the conference was held April 29, 1958, at Santa Fe, New Mexico and a second session was held June 24, 1959, at Santa Fe. A mill of the Vanadium Corporation of America, abandoned mines, and the municipalities of Durango and Silverton, Colorado were involved. The conferees found pollution of the Animas River was caused by discharges of uranium milling wastes and toxic chemicals from the Vanadium Corporation of America at Durango, Colorado.

The Vanadium Corporation complied with the conference schedule by January 1960 by construction of necessary facilities and treatment is satisfactory. The Public Health Service made additional recommendations which were followed by the Corporation and surveillance is continuing. The river has now been incorporated in the Colorado River Basin Project.

9. Missouri River, Sioux City Area (South Dakota - Iowa - Nebraska - Missouri - Kansas)

A conference was held July 24, 1958, at Sioux City, Iowa. Sewage and industrial wastes from sources in South Dakota, Nebraska, and Iowa caused pollution of the Missouri River so as to endanger the health and welfare of persons in States other than that in which the discharges originated. Major source of the pollution was Sioux City and its associated industries, notably meat packing plants. A schedule of necessary remedial measures was established by the conferees.

Failure to abide by the schedule necessitated the calling of a public hearing by the Secretary of Health, Education, and Welfare on Sioux City and ten industries, March 23-27, 1959. Sioux City, the major source of pollution, has now completed its sewage treatment plant at a cost of $2.3 million. Most of the major interceptor sewers have been completed. Industries named in the hearing proceedings, including Swift & Company, Armour & Company, and other meat packing plants, are planning connection to the municipal system.

10. Lower Columbia River (Washington - Oregon)

The conference was held on September 10-11, 1958, and followed by a second session September 3-4, 1959. Waste discharges from Portland, Oregon, Vancouver, Washington, 47 other communities, and 21 industries, among them Crown Zellerbach Corporation, Weyerhauser Timber Company, and other pulp and paper companies, were involved.

A remedial time schedule for pollution abatement was recommended by the conferees. In Portland, Oregon, the voters approved financing for treatment facilities on November 8, 1960. All Washington municipalities and industries, including some of the nation's largest pulp and paper companies, are reported in compliance by the State with the exception of Vancouver and Cathlamet where construction is expected shortly. Oregon reports all municipalities and industries now provide year-round chlorination of sewage effluents discharged directly to the Lower Columbia River. Some of the industrial methods of treatment are still being evaluated.

11. Bear River (Idaho - Wyoming - Utah)

The first session of the conference was held on October 8, 1958, followed by a second session July 19, 1960. Major sources of pollution were wastes from sugar, meat and milk processing industries in Idaho and Utah.

After the second session of the conference, the Surgeon General recommended a time schedule for remedial action. Several municipalities in Idaho have completed treatment facilities in compliance with conference recommendations. The sugar and milk industries in these States have made great strides in meeting their waste treatment needs. Further studies have been performed and are in process of being evaluated.

12. Colorado River and All Its Tributaries (Colorado - Utah - Arizona - Nevada - California - New Mexico - Wyoming)

There have been four sessions of the conference on the Colorado River to date: the first on January 13, 1960; the second May 11, 1961; the third May 9-10, 1962; and the fourth May 27, 1963. At the first session the conferees decided that further investigation and study was needed to define the type of interstate pollution problems which may exist in the interstate waters of the Colorado River and its tributaries. At the second session the conferees agreed on matters which should receive the greatest attention in the studies of the river. At the third session, the status of the investigations and studies and progress in technical aspects of the studies of the river were reported, as well as progress in pollution abatement on the Animas River, a tributary of the Colorado. At the fourth session the conferees agreed that salinity of water was the major problem demanding attention.

Radioactive wastes have been so reduced that the radium content of the waters of the Colorado and its tributaries does not exceed 1 uuc/l or about 1/3 the amount allowed in the PHS Drinking Water Standards.

Field studies and investigations are being conducted currently to determine the extent of pollution by cities, industries, and irrigation projects. The expected date of the completion of these comprehensive studies is 1966.

13. North Fork of the Holston River (Tennessee - Virginia)

The first session of the conference was held September 28, 1960, with a second session being held June 19, 1962, involving discharges from the Olin-Mathieson Chemical plant at Saltville, Virginia. Calcium and sodium chlorides in these wastes are a major source of pollution. The extent of deterioration of water quality and interferences with water uses was not agreed upon at the first session of the conference; however, it was agreed that interstate pollution subject to abatement under the Federal Water Pollution Control Act was occurring. Olin-Mathieson is increasing the size of its impounding reservoir. This will not provide a permanent solution to the pollution problem but will remove peaks in chloride discharges enabling downstream users to make necessary adjustments.

14. Raritan Bay (New York - New Jersey)

The first session of a conference was held August 22, 1961, at New York, New York, and the second session was held on May 9, 1963, also in New York City. Discharges of untreated and inadequately treated sewage and industrial wastes by municipalities and industries in New Jersey and New York pollute the interstate waters of the Raritan Bay so as to endanger the health and welfare of persons in these two States.

The conferees at the first session found that scientific data taking into account a wide range of factors and technological problems, including health, conservation, water policy and uses, and industrial processes were urgently needed, and are the critical issue in further control of pollution of these waters. They agreed at the second session to the continuation of ongoing studies being made to determine the extent and the effects of the pollution and to furnish a basis for recommendation of remedial measures. This area includes one of the largest industrial and municipal complexes in the country.

15. North Platte River (Nebraska - Wyoming)

Two sessions of the conference were held, the first September 12, 1961, and the second March 21, 1962. A third session is scheduled for November 20, 1963. Thirteen municipalities and fourteen industries are involved. Discharges of industrial and municipal wastes in Wyoming below Torrington, with wastes discharged from the sugar beet processing companies a major source, pollute this stretch of the river.

In general, the sugar beet industry in these two States has made great strides in treating their industrial wastes. The sugar beet mill at Torrington has installed remedial facilities. Industrial wastes from Mitchell, Gering, Scottsbluff, and Bayard, Nebraska, and municipal wastes from numerous cities in Nebraska require waste treatment facilities. A time schedule has been established for construction of facilities by municipalities in that State; and construction is taking place.

16. Puget Sound, Upper Columbia River (Washington)

At the request of the Governor of the State of Washington, a conference was held on January 16-17, 1962, at Olympia, Washington, on pollution of the Puget Sound, the Strait of Juan de Fuca, and all navigable estuarine waters and navigable streams. A second session on the Upper Columbia River, and navigable tributaries in Washington will be held at a later date.

The discharges causing and contributing to pollution in these waters come from various industrial and municipal sources, notably from the pulp and paper industry. Industries involved include Scott Paper Company, Rayonier, Inc., Weyerhaeuser Timber Company, Fibreboard Products, Inc., and Puget Sound Pulp and Timber Company.

The industries named at the conference as sources of industrial pollution were required by the conferees to control their waste discharges at least to the extent specified in the temporary permits issued to them by the Washinton Pollution Control Commission. A time schedule for remedial action by these industries was established by the conferees requiring completed and approved engineering plans and specifications by January 1963.

The conferees recommended further that representatives of both the State of Washington and the U. S. Department of Health, Education, and Welfare develop a joint program to carry out such investigations and studies of the river as are required. Comparative studies are now being made on various aspects of pollution problems in this area: oceanographic, biological, chemical and economic.

17. Mississippi River, Clinton, Iowa Area (Illinois - Iowa)

A conference was held at Clinton, Iowa on March 8, 1962. Discharges causing and contributing to pollution from industrial and municipal sources in Iowa caused interferences with uses of the river for public and industrial water supplies, commercial and sport fishing, recreational purposes and the aesthetic enjoyment of the river.

Among the industries involved are Pillsbury Company, Dairypak Company, Swift and Company, and Clinton Corn Processing Company. The conferees recommended a time schedule for remedial action on the entire reach of the river involved. The cities of Clinton and Comanche, Iowa, along with industry, are taking action to meet this time schedule.

18. Detroit River (Michigan)

The Governor of the State of Michigan requested on December 6, 1961, that the Secretary of the Department of Health, Education, and Welfare call a conference on the navigable waters of the Detroit River and its tributaries within the State of Michigan. The conference was held March 27-28, 1962, involving a considerable number of communities and industries. Some of the industries involved include Chrysler Corporation, Mobil Oil, Monsanto Chemical, Firestone, and innumerable others.

The conferees agreed that an investigation and study of the river is necessary in order to determine sources of pollution, nature of pollution and the effects thereof, appropriate methods of abatement, and appropriate methods to avoid delays in abatement. This investigation and study was established and is continuing. The conference will be reconvened at the call of the Chairman with the concurrence of the Michigan Water Resources Commission to consider the results obtained from the investigation and study, and to agree on action to be taken to abate pollution.

19. Androscoggin River (New Hampshire - Maine)

The first session of the conference was held September 24, 1962, at Portland, Maine and continued on February 5, 1963. Reports, surveys, and studies indicated that pollution from industrial and municipal sources is occurring in the interstate waters of the Androscoggin River. This pollution makes the river unsuitable and unsafe for most legitimate water uses.

At the conference representatives from the States of New Hampshire, Maine, and the New England Interstate Pollution Control Commission refused to serve as conferees, but in the second session participated in the conference discussion from seats in the audience.

20. Escambia River (Alabama - Florida)

Wastes from communities and industries were involved in proceedings at this conference which was held on October 24, 1962. The conferees found that pollution of interstate waters subject to abatement under the Federal Water Pollution Control Act was not occurring in the Escambia River at that time. Although the municipalities of Brewton, East Brewton and Flomaton in Alabama were not providing treatment for their wastes, it was not demonstrated that their discharges had any interstate effect. Two of these communities now have active programs for the construction of treatment facilities. The industries on the river in Alabama have taken measures to avoid water pollution.

21. Coosa River (Alabama - Georgia)

At this conference held August 27, 1963 in Rome, Georgia, the pollutional effects of waste discharges of three municipalities and more than eleven industries were considered. Remedial schedule established.

22. Pearl River (Louisiana - Mississippi)

A conference was held October 22, 1963 in New Orleans, Louisiana involving at least two municipalities and two major industries. Remedial schedule established.

23. South Platte River (Colorado)

The Governor of Colorado on July 18, 1963 requested that the Secretary of Health, Education, and Welfare take action under section 8 of the Act on the intrastate navigable waters of the South Platte River Basin. Accordingly a conference was held on October 29, 1963 in Denver, Colorado, principally involving waste discharges from the Denver metropolitan area, 13 other municipalities, 10 Great Western Sugar processing plants, the Packaging Corporation of America, and numerous mining and oil extracting and processing industries. At the conference it was agreed that Metropolitan Denver Sewage Disposal District No. 1 will collect and provide secondary treatment for all wastes within its district, to be in operation by 1966. Commensurate schedules will be adopted for other communities and industries which have not joined the Metropolitan Denver Sewage Disposal District. The Conferees further agreed that the U. S. Department of Health, Education, and Welfare in cooperation with the Colorado State Department of Public Health will initiate a joint investigation and study to determine the nature and extent of pollution in the South Platte River Basin.

24. Menominee River (Michigan - Wisconsin)

A conference was held November 6-8, 1963 at Menominee, Michigan, to consider pollutional effects of municipal and industrial waste discharges from both States. At least seven industries, among them Kimberly-Clark Corporation, Scott Paper Company, and Marathon Division of the American Can Company, and eleven municipalities are involved. A remedial schedule for pollution abatement was established.

25. Connecticut River (Massachusetts - Connecticut)

The conference was held December 2, 1963 at Hartford, Connecticut. Principal sources of pollution were waste discharges from at least 26 municipalities and 20 industries. A remedial schedule was established by the conferees.

26. Monongahela River (West Virginia - Pennsylvania - Maryland)

The conference was held December 17-18, 1963 at Pittsburgh, Pennsylvania. Involved at the conference were more than 94 municipalities and 93 industries. One of the principal sources of pollution is coal mine drainage. The State of Pennsylvania has a program to abate pollution from municipal and industrial sources by the end of 1966. Commensurate programs have been developed by West Virginia and Maryland. The conferees recommended the establishment of a technical committee consisting of representatives of West Virginia, Pennsylvania, Maryland, the Ohio River Valley Water Sanitation Committee, and the Federal Government to explore the means of abating pollution caused by coal mine drainage.

27. Snake River, Lewiston-Clarkston Area (Idaho - Washington)

Conference scheduled to be held January 15, 1964.

28. Upper Mississippi River (Minnesota - Wisconsin)

Conference scheduled to be held February 7, 1964 at St. Paul, Minnesota.

29. Merrimack-Nashua River (New Hampshire - Massachusetts)

Conference scheduled to be held on February 11, 1964 at Boston, Massachusetts.

Accomplishments in Reducing Pollution

Federal enforcement procedures to abate pollution have been instituted in 29 separate instances to date. A total of thirty-six States and the District of Columbia have been parties to these actions. They involve some 680 municipalities and about 730 industrial plants. Large metropolitan areas, such as New York City, St. Louis, the Kansas Cities area, and Portland, Oregon, and larger corporations such as General Motors, Standard Oil, Shell Oil, Swift, Armour, Crown-Zellerbach, Olin-Mathieson Chemical, and the Vanadium Corporation of America have been covered in these actions. Over 7,000 miles of major water bodies are affected.

As a result of these actions, remedial collection and waste treatment facilities at an estimated cost of $750 million are in various stages of planning, construction, and operation. This cost figure is expected to rise substantially when schedules of remedial action are established for several large areas now under Federal enforcement actions.

In abating these sources of pollution, the Federal enforcement actions have produced a significant accompanying result. When compliance is obtained on the part of the polluters under enforcement proceedings, other communities in the enforcement area, which have delayed instituting their own treatment practices because the larger upstream neighbor has been dilatory in this regard, voluntarily proceed with the installation of needed facilities. Thus, a kind of chain reaction results which is often effective throughout a larger section of the stream than is actually subject to the enforcement proceedings.

In a majority of the actions, the conference stage has proved effective. The hearing stage has been necessary only in four instances, and court action was necessary only in one case.

COMPREHENSIVE PROGRAMS FOR WATER POLLUTION CONTROL

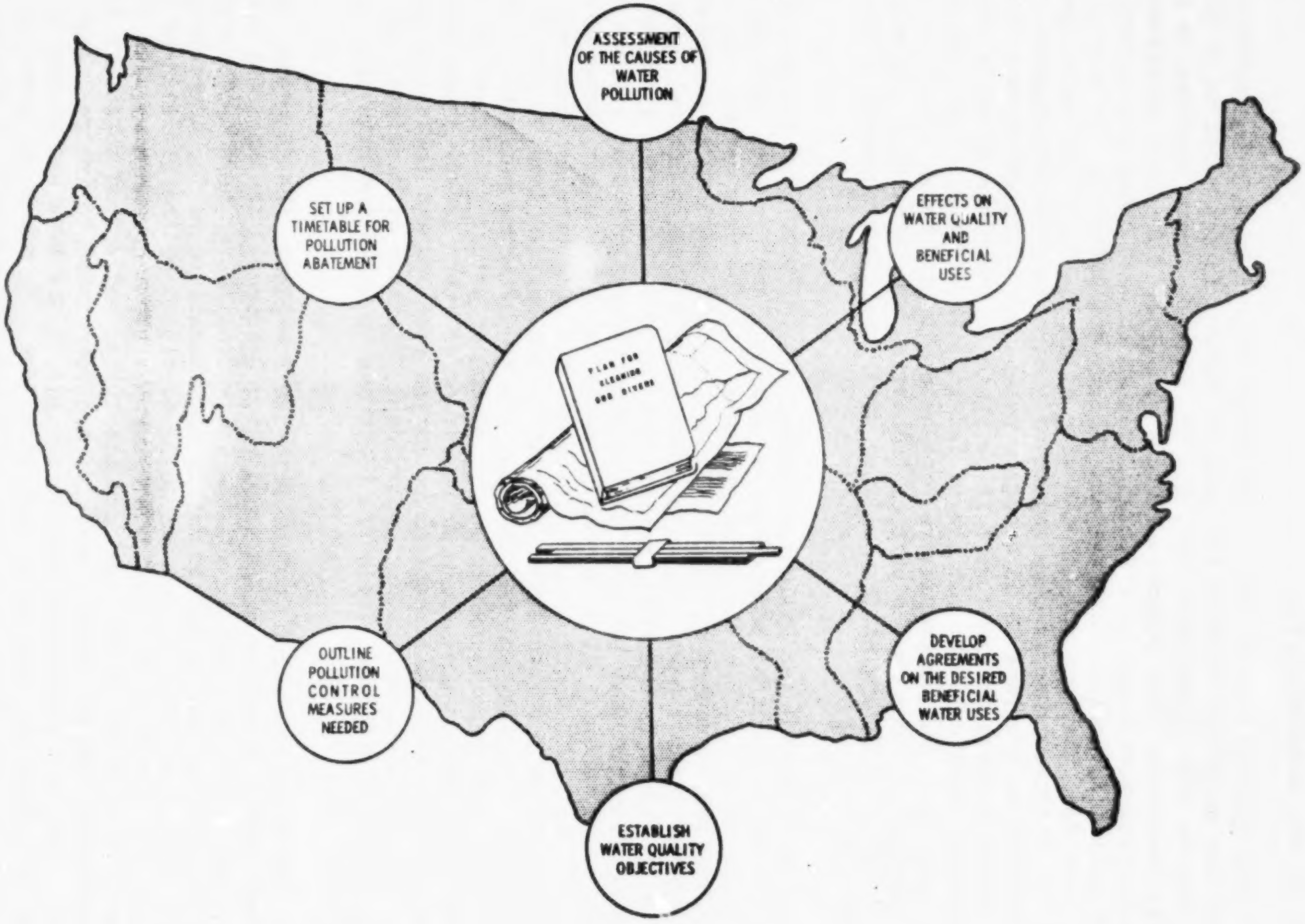
Nature of Comprehensive Programs

Comprehensive water pollution control programs are being prepared to insure that water of proper quality is available in the proper place at the proper time to support an expanding economy; to fulfill the Nation's desire for clean water to support recreation and instream uses; and to insure that these objectives are achieved with maximum efficiency, optimum expenditure, and equitable distribution of water pollution abatement costs. They are aimed at permitting use and reuse of our water resources many times over.

Water pollution control is achieved through collection and treatment or removal of wastes at their source and through storage in reservoirs to provide streamflow regulation for quality control. In effect, storage and waste treatment are the main features of the national water resources

COMPREHENSIVE PROGRAMS

For River Basins


ASSESSMENT OF THE CAUSES OF WATER POLLUTION
EFFECTS ON WATER QUALITY AND BENEFICIAL USES
DEVELOP AGREEMENTS ON THE DESIRED BENEFICIAL WATER USES
ESTABLISH WATER QUALITY OBJECTIVES
OUTLINE POLLUTION CONTROL MEASURES NEEDED
SET UP A TIMETABLE FOR POLLUTION ABATEMENT
PLAN FOR CLEANING OUR RIVERS

PROVIDE FOR ORDERLY AND EFFICIENT WATER QUALITY CONTROL OF THE NATION'S WATER RESOURCES

program. When treatment and sufficient storage are provided to insure a regulated supply of high-quality water, most other water resources problems will be met simultaneously.

The minimum annual cost to the Nation for collection and treatment of waste and reservoir storage for quality control is estimated to be $2.4 billion by 1980 (Committee Print No. 32, Senate Select Committee on National Water Resources, 86th Congress, Second Session). Efficient management of this expenditure would be difficult even if it were under the control of one central authority. With responsibility and authority for determining the need for, the type of, and the size of expenditures for water quality control diffused through many layers of government, the development of comprehensive programs is an economic necessity. Comprehensive water pollution control programs make it possible to formulate mutually supporting plans and coordinate the actions of Federal, interstate, State, and municipal agencies. The comprehensive program provides a basic resource for enlightened actions on the part of industries and interested citizens groups. We must have a blueprint for building water quality management into each river basin system.

The Federal Water Pollution Control Act (33 USC 466a) assigns authority for the development of comprehensive programs, and provides guidance on the elements to be included in those programs. At the very outset, the Act requires the Secretary of Health, Education, and Welfare, in cooperation with other Federal agencies, with State water pollution control agencies, and with all other agencies, municipalities, and industries involved to develop comprehensive programs for eliminating pollution of surface and underground waters. It is strongly implied that the other elements of the Act will be applied within the framework of a comprehensive program. Thus the provisions for interstate cooperation and uniform laws; research, investigations, training, and information; grants for water pollution control programs; grants for construction of treatment works; provisions for a water pollution control advisory board; enforcement measures against pollution; and cooperation to control pollution from Federal installations can all be taken as important, but individual, elements of a nation-wide comprehensive program. These are the means by which the plan will be implemented.

The Water Pollution Control Act, the President, the Congress, the Senate Select Committee on National Water Resources, the National Conference on Water Pollution Control, and the individual States have influenced the formulation and helped to define the dimensions of the comprehensive Water Pollution Control programs being developed by the Division of Water Supply and Pollution Control. The programs are comprehensive with respect to time in that existing problems are identified and solved to obtain immediate improvement, and preventive measures are formulated to insure future protection. They are comprehensive with respect to the type and source of pollution including all substances that interfere with man's enjoyment or use of water whether those substances originate from man-made or natural sources. The programs are comprehensive with respect to coverage including groundwater, lakes, estuaries, and coastal waters as well as the flowing streams of the country. They are comprehensive with respect to water use giving due regard to the improvements necessary to conserve waters for public water supplies, propagation of fish and aquatic life, other wildlife, recreational purposes, agricultural and industrial uses and all other legitimate uses. They are comprehensive in terms of participation; serving to coordinate the actions of water pollution control authorities at Federal, interstate, State, and municipal levels; giving impetus to the efforts and providing a background for action of citizens' groups interested in the preservation of clean water; and providing a basis for mutual cooperation of industries, municipalities, and operating agencies at all levels of government. Last, but not least, the programs are comprehensive in technology, incorporating the contributions of biologists, chemists, economists, engineers, microbiologists, oceanographers, and other scientific skills capable of contributing to a factual, scientific basis for a comprehensive water pollution control program.

An optimum plan for applying the various means and measures of controlling water pollution and preserving the quality of water for legitimate uses now and in the future is a major element of the comprehensive program. Many of the intensive investigations are undertaken to provide factual data for the plan. Knowledge is needed of the rate of economic development; of the time and place where water uses are likely to develop; of likely recreational trends and water needs; and of the quantity, character, time and place of probable waste discharges. Engineering data and operations analysis are needed to combine cost and effectiveness of various pollution control measures with benefits obtained to determine optimum conditions. The combination of measures to produce maximum results with minimum expenditure will vary according to time and place in the basin and according to the nature of water resources (surface streams, groundwater, estuaries, coastal waters) to be protected.

To insure that control measures are effective and that wasteful inefficiency is avoided, a wide spectrum of scientific information and economic projections are required. The type and priority of individual investigations will vary from one basin to the next depending on the nature of water resources and the existence of pressing problems in any particular river basin. However, as a general rule, the following information is assembled in each major water resource basin; (1) economic projections over a period sufficiently long to evaluate trends and permit long-range planning; (2) hydrological data and interpretative material; (3) basic information of the water resources' physical and biological characteristics; (4) projections of potential water uses and waste water discharges over the period of planning; (5) estimates of capability for collecting and treating wastes during the planning period; (6) calculation of streamflow regulation required to reduce the adverse effects of pollutants that can not be removed or treated adequately at the source; and (7) operational or systems analysis for determining timing and optimum cost of control measures and other activities required to implement the comprehensive program. The comprehensive program will provide guidelines for establishing and meeting water quality criteria by water pollution control agencies at all levels of government. The program also will provide a scientific basis for appraising the effect of reservoirs, diversion works, outfalls, and other construction activities on the quality of the natural water resources.

Plans for Developing Comprehensive Programs

In December of 1960 the National Conference on Water Pollution Control recommended that planning for the comprehensive development of each major river basin for water resources be established as a fixed national policy. The Senate Select Committee recommended that these comprehensive plans be completed by 1970. President Kennedy, in his Natural Resources Message of February 23, 1961, spoke of the urgency of developing comprehensive plans and stated that his administration accepted the goal urged by the Senate Select Committee on National Water Resources to develop comprehensive river basin plans by 1970.

The development of comprehensive programs to improve the quality of surface and groundwater and to preserve the quality of those waters for all beneficial uses has now been designated as a major goal of the Federal Government. The present administration has recently initiated a major effort designed to coordinate the budgets of all water resource agencies and reducing overall costs. This effort may result in a modification of the target date for the completion of comprehensive basin plans.

In cooperation with the States, comprehensive programs will be developed in all major drainage areas of the United States. The criteria used to establish priority for the development of comprehensive programs are (1) the need to resolve critical water problems where pollution has curtailed water uses; (2) urgency to integrate comprehensive water pollution control planning with planning for water resources development and construction schedules of the Bureau of Reclamation, Corps of Engineers, Department of Agriculture, and the States; and (3) readiness of Federal, State, interstate, and local groups to collaborate.

Water pollution control exerts a strong influence on the plans for the construction of reservoirs and other water resources structures. Projections of water uses, water quality required to serve those uses, projections of waste water discharges, estimates of maximum efficiency of waste collection and treatment works, and fundamental scientific information that describes the effect on water quality of proposed water resources developments are important features that should be taken into consideration by the construction agencies. Costly errors will be avoided and the optimum development of the nation's water resources will be enhanced by the early development of comprehensive water pollution control programs.

Current Comprehensive Program Activities

There are two phases in the development of comprehensive water pollution control programs. These are: (1) the development phase (intensive investigations, planning, and program formulation); and (2) the management phase (implementation of the program, including monitoring).

At the present time, intensive investigations are in progress in the Chesapeake Bay-Susquehanna River Basin, the Columbia, the Delaware, the Great Lakes-Illinois, the Ohio, and the Southeastern River Basins.

Funds appropriated to date for the preparation of these comprehensive programs are as follows (in thousands of dollars):

Basin	1958	1959	1960	1961	1962	1963	1964
Arkansas-Red	85	85.5	375.5	515	453	361	116
Great Lakes-Illinois				500	1,520	3,180	2,596
Columbia				95	193	236	375
Chesapeake Bay-Susquehanna				45	50	250	405
Delaware				--	55	150	286
Ohio				--	--	100	495
Southeastern				--	--	--	195
Total	85	85.5	375.5	1,155	2,271	4,277	4,468

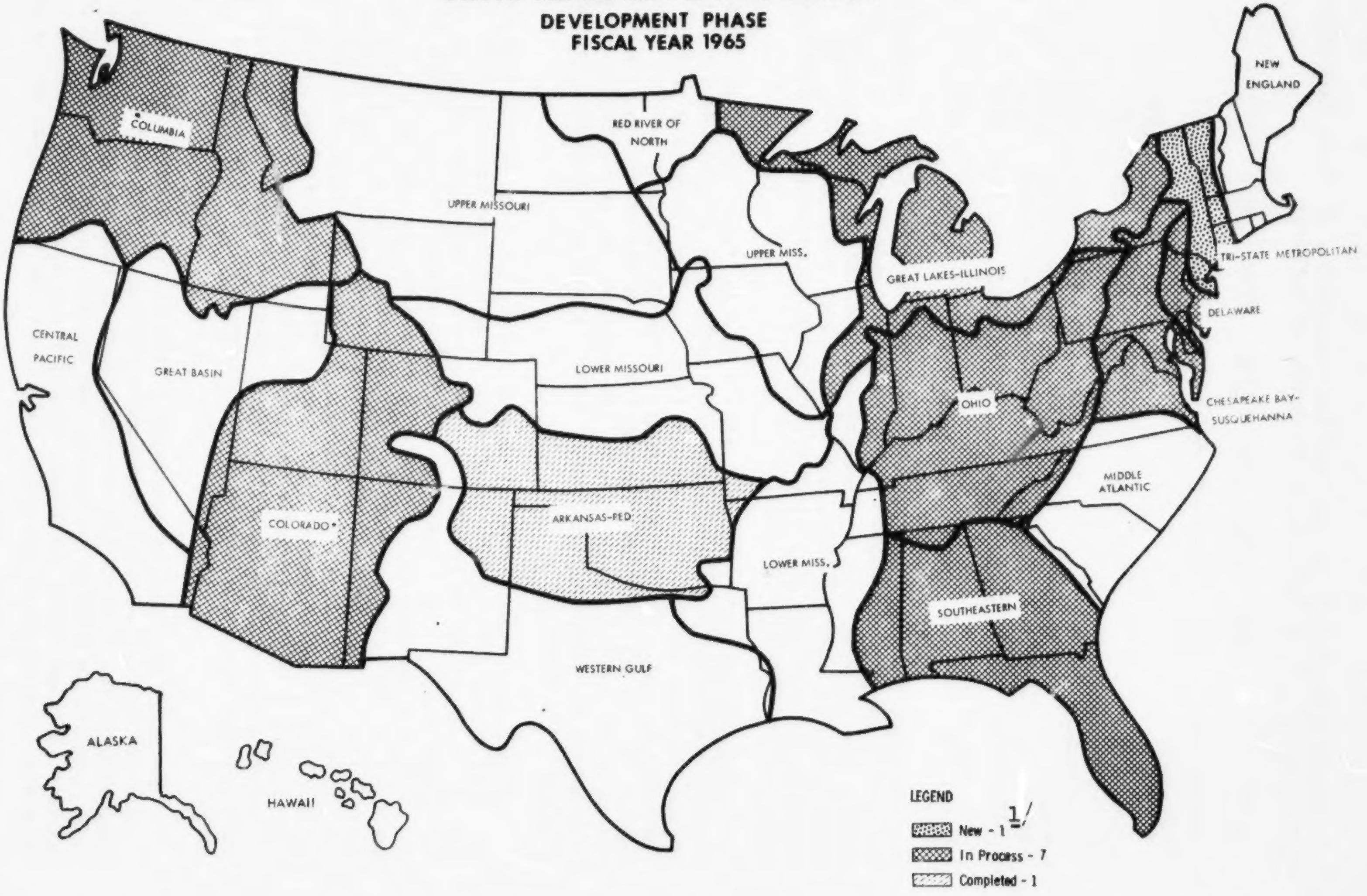
Although the basic purpose of each comprehensive project is much the same, each project now under way has been initiated in response to special needs. The approach used in planning has been tailored to the particular water resource potentialities and needs of each basin involved. The location and coverage of present and proposed comprehensive projects are shown on the accompanying map.

Arkansas-Red River Basins - Under P.L. 660, the first major effort to develop comprehensive programs for water pollution control was initiated in the Arkansas and Red River Basins in 1957. The basins are part of the Southwestern and Central Plains region. They comprise an area of approximately 354,000 square miles, roughly 10% of the United States. Approximately 7,300,000 people now live in the Arkansas-Red River Basins in all or portions of Arkansas, Colorado, Kansas, Louisiana, Missouri, New Mexico, Oklahoma, and Texas.

In the water-short area of the southwest, the flow in the upper reaches of these rivers is heavily contaminated by natural pollution. Salt springs and soluble rock formations contribute approximately 62,000 tons of salt and gypsum to the rivers each day. Brine discharged at oil fields increases the pollution so that waters in the upper and middle reaches and their tributaries are unfit for most beneficial uses. Even after significant dilution with high quality rainwater runoff downstream in the eastern part of the basins, salt still imposes an economic burden on water uses in the downstream reaches of the rivers. The immediate objective in the development of a comprehensive program for the Arkansas - Red Rivers was to eliminate or substantially reduce the discharges from sources of brine so that the water may be used to support the expanding economy of the area.

The first step was to determine if the natural sources of salt pollution could be located and brought under control. Intensive investigations completed in the fall of 1962 revealed that 15 isolated points in the basin contribute a major portion of the natural pollution. At each of these sources (springs, seeps, and salt flats) there are several possible means of controlling or eliminating the salt flow. As recommended by the Arkansas -

STATUS OF
COMPREHENSIVE PROGRAM
DEVELOPMENT PHASE
FISCAL YEAR 1965


NEW ENGLAND
TRI-STATE METROPOLITAN
DELAWARE
CHESAPEAKE BAY-SUSQUEHANNA
MIDDLE ATLANTIC
SOUTHEASTERN
OHIO
GREAT LAKES-ILLINOIS
UPPER MISS.
LOWER MISS.
RED RIVER OF NORTH
UPPER MISSOURI
LOWER MISSOURI
ARKANSAS-RED
WESTERN GULF
COLORADO*
GREAT BASIN
CENTRAL PACIFIC
COLUMBIA
ALASKA
HAWAII
LEGEND
New - 1 1/
In Process - 7
Completed - 1

*ENFORCEMENT

JANUARY 1, 1964

1/ Assumes that Congress will provide for Tri-State Metropolitan study in 1965 appropriation

White - Red River Basins Interagency Committee Report of January 1957 (Senate Document No. 13, First Session, 85th Congress), the Project is a cooperative venture with the Corps of Engineers. The Public Health Service located and characterized the seeps, springs, and salt plains where natural pollution enters the rivers. The Corps of Engineers is investigating the sites identified by the Public Health Service to determine the cost and feasibility of various control measures.

The Public Health Service' Arkansas - Red Rivers Basins Project's development phase has now been completed and a report will be submitted to Congress during calendar year 1964. While working with the Corps of Engineers to find economical methods for controlling natural pollution, the Project also is cooperating with State and interstate agencies to bring man-made sources of salt pollution under control.

A small staff has remained to conduct continuous monitoring activities as part of the study's management phase. A network of salinity measuring stations has been installed to judge the effectiveness of control works as they are built and put into operation. The monitoring network will also provide information to serve as the basis for desirable modification of the program as it progresses. Eventually, the monitoring network will provide operating guidance to the agencies having control over reservoir and diversion works in the two basins so that streamflow can be regulated to improve water quality.

A satisfactory completion of the salinity control program, will make available 31 million acre-feet of good quality water for continued economic growth. As the quality of water improves and is put to use in the expanding economies of the basins, other types of water quality management problems associated with urban, industrial and agricultural development will arise. As the situation develops, the comprehensive plan and program will be adjusted to insure that the more common types of municipal and industrial pollution do not offset the advantages gained through salinity control.

Chesapeake Bay - Susquehanna River Basins - The Chesapeake Bay - Susquehanna River Project got underway in the late summer of 1960. Because of funding limitations, it did not become fully operational until 1963. The Project area encompasses parts of the States of New York, Pennsylvania, Maryland, and Virginia. The two waterways form an integrated water system that represents a major fraction of the water resources of the upper Atlantic region of the nation.

The Chesapeake Bay is perhaps the largest fishing and recreation area on the Atlantic coast. It is the home of a large game and commercial fisheries industry and the waters must serve increasing demands for municipal and industrial development. It is expected that 15 million persons will reside in the region surrounding the Chesapeake estuary by the year 2010, triple the present number. Water supply for these people, and waste disposal practices that will preserve the recreational potential of the Chesapeake Bay are major water quality management problems of immediate concern.

A major pollution problem at the present time in the Susquehanna basin is acid mine drainage which limits the use of water for municipal and industrial as well as recreational purposes. The area is undergoing a transition to new industry to replace the coal mining industry. Water quality and availability are predominant factors in industrial relocation. The comprehensive water pollution control program under development will have as its goal good quality water for new industrial use and will protect the quality of water as the industries develop.

A field station has been opened at New Cumberland, Pennsylvania, to serve as a base of operations for the Susquehanna River. High priority was given to a series of studies to determine the time-of-passage in tributaries and critical sections of the main stem of the river. Time-of-passage is an important factor in many water quality calculations and the information was sorely needed by State water pollution control agencies. From the office in Harrisburg and another opened in Baltimore, Maryland, the Project worked in cooperation with the States to assemble an up-to-date inventory of municipal and industrial water uses and waste water discharges.

Working with the Corps of Engineers and the Department of Interior, the Project perfected and is putting into operation a system for handling data pertinent to the Susquehanna River - Chesapeake Bay area. Water quality data care costly to obtain and they must be made to serve as many purposes as possible. Many groups and agencies need access to these data to carry out their responsibilities. This broad usage places great importance on uniformity of sampling and analytical procedures and calls for an efficient system for data storage and retrieval.

The system being put into operation in the Chesapeake - Susquehanna Project was developed by the Basic Data Branch of the Division of Water Supply and Pollution Control, and it will be used in all of the comprehensive programs. Because it is an efficient system not only for data retrieval but also for furnishing a convenient coordinate network for the solution of many engineering problems, this system is receiving widespread attention from the other water resources agencies, and its broad adoption is expected within the next few years.

Economic studies are proceeding in a satisfactory manner. The Corps of Engineers and the Public Health Service are jointly financing a contract with the National Planning Association to meet the basic needs of the two agencies for economic data. In addition to the work by the National Planning Association, agricultural projections are being made by the Economic Research Service, the U. S. Department of Agriculture; and the Bureau of Mines is assembling information on each of the mineral industries in the Project area. A careful cooperative effort is being made to make certain that the Federal agencies operating in the Chesapeake - Susquehanna area base their actions on a common background of economic information.

Under contract with the Public Health Service, the Chesapeake Bay Institute at Johns Hopkins University is completing a two-year study of all existing water quality information concerned with the Chesapeake Bay. This review puts existing information in a useful, readily available form. It also defines the gaps in knowledge where further investigations are needed. For instance, it has been revealed that a far better understanding of the currents and mass movements of water in the estuaries leading into the Bay is needed to permit rational location of waste water outfalls and predict the long-range effect of various types of pollution entering the Bay.

If budgetary support is forthcoming, dye studies and other oceanographic investigations will commence in 1965. To support these studies, a field station in the Annapolis, Maryland, area will be established late in FY 1964. In addition to the studies on the Bay, a major program of sampling and measurement in the Susquehanna River Basin will be undertaken.

Columbia River Basin Project - The Columbia Project covers the States of Washington, Oregon, and parts of Idaho and Montana. Investigations were commenced in 1962. A comprehensive plan is being developed to meet water requirements of the Pacific Northwest over the next half-century, with intermediate forecasts for a mid-period, 1980.

The water pollution control plan will emphasize prevention. While the area now has vast supplies of high quality water, the anticipated growth of population and the expansion of the economy will increase the amount and variety of wastes to be discharged to the waterways. Without benefit of a comprehensive water pollution control program, deterioration of water quality experienced in other parts of the country may result.

A study plan was prepared and priorities of investigations were assigned after consideration of the proposed activities of other Federal agencies, and the anticipated location and rate of population growth and industrial development. The total area was subdivided into 12 subbasins for a three-phase study plan. The first phase is concerned with the subbasins having existing problems associated with municipal, industrial, and agricultural development. At the present time, investigations are in progress in the Yakima, Willamette, Upper Snake, and Lower Columbia areas. These studies will be substantially complete by the end of FY 1964. At that time, investigations will be expanded to include the other subbasins.

Under contract with the Public Health Service, Washington State University, at Pullman, Washington, constructed a scale model of the Umpqua River Estuary. Tests with this model have demonstrated the probable distribution and dispersion of wastes matter that might be introduced into the estuary. The model will be helpful in water pollution control work planned for several estuaries in the Pacific Northwest.

A major investigation concerns silt in surface runoff. Silt is produced in lumbering, road construction, and other land use practices. Silt is particularly harmful to salmon and other game fishes and imposes an economic burden by decreasing the capacity of reservoirs and increasing the cost of water treatment at municipalities and industries. A report on sedimentation production in the Pacific Northwest has been prepared, and work is proceeding the determine modifications in forestry, road building, and other land management practices which might be instituted to minimize the silt load in surface runoff.

A major effort is being made to prevent water pollution from damaging the unique fisheries and recreational opportunities found in the coastal drainage areas of Washington and Oregon. The shellfish of Puget Sound are particularly susceptible to the effect of industrial waste from existing industries and industries likely to locate along its shores. To protect the fish and shellfish resources, oceanographic studies in the major estuaries and coastal areas will be intensified. An increase in temperature renders anadromous fishes susceptible to devastating diseases, therefore, temperature is an important pollutant in the Pacific Northwest. The temperature of surface streams is increased by present design and operation of reservoirs. Studies are in progress to find means of reservoir design and operation which will minimize temperature increases.

The plans for construction of reservoirs and full development of water resources for power, irrigation, and flood control are well advanced in the Pacific Northwest. It is imperative that water quality control plans be brought abreast of the others. The Project is effectively coordinating the activities with other Federal and State agencies through the Columbia River Basin Inter-Agency Committee.

Delaware Estuary - The Delaware River Estuary Project was initiated in 1962. Upon cmmpletion of a water resources development plan for the Delaware River Basin under sponsorship of the Corps of Engineers, it was found that extensive water quality studies in the estuary, below Trenton, New Jersey, were still needed. The States of Pennsylvania, New Jersey and Delaware; the City of Philadelphia, and the Interstate Commission on the Delaware all requested that the Public Health Service undertake those studies.

In the last decade, the industrial growth of the area has been twice the national rate. In 1960 alone, more than $600,000,000 was spent by industry for new plant and equipment. The area has the largest oil refinery complex on the East Coast of the United States. Primary metal industries are a large user of water in the basin. As a result of the rapid economic growth, industrial and municipal water requirements have become critical factors.

In addition to the municipal and industrial problems, it is also necessary to determine the effects of changes in the estuary that may result from the construction of Federal reservoirs, now contemplated, in the Delaware Basin. Information derived from fundamental studies of the estuary is needed without delay by communities planning expenditures for water supply and sewage treatment works. For instance, the City of Philadelphia is planning to spend $27,000,000 on the improvements of water purification and water intake facilities. The city needs reliable information to predict the fate of waste discharges, and in turn, the effect of waste discharges on quality raw water in the Delaware Estuary.

As a first step in the development of a water pollution control program, the relationships and responsibilities shared with States and interstate agencies were established. The field investigations included a large-scale dye study of the estuary to compare actual water movements with results obtained from a physical model built and operated by the

Corps of Engineers. The tests illustrated the need for a full-scale study of the estuary to define mixing and dispersion of wastes discharged into it.

Of particular interest to water pollution control agencies throughout the country is the mathematical model for predicting dissolved oxygen conditions in the Delaware Estuary. This model was conceived by the Project, and is reaching an advanced stage of completion. Theory has been perfected, and a check of the theory against continuous measurements at many points in the estuary for a full year shows remarkable agreement. This model may provide a breakthrough for scientific management of waste treatment facilities and streamflow regulation structures to give predictable quality conditions at desired location in a water resource system. The model, as well as being of extreme importance to the Delaware, will be highly useful in other projects and will point toward the type and extent of investigations needed in other estuaries.

Great Lakes - Illinois River Basins - The 1961 Appropriations Act contained an item of $500,000 to commence development of a comprehensive water pollution control program for the Great Lakes. The Great Lakes form the world's largest impoundment of fresh water and constitute a priceless national resource. Their quality affects the health and welfare of millions of people and will materially influence the economic development of a large portion of the United States. The effects of water pollution are seen in the increasing difficulties in treating lake water for domestic and industrial uses, the increasing number of bathing beaches closed, and the change from prized game fish to rough varieties in major parts of the lakes.

Because the lakes can not flush themselves and thus purge pollution in the manner of a flowing stream, once their quality is destroyed, generations may pass before it is restored. It is urgent to pinpoint the threats to water quality and take preventive measures before irreversible damage is done. In areas where quality has already been damaged, knowledge is needed to find means of speeding recovery after pollution is stopped.

During the first three years special effort was made in the Illinois waterway and the southern end of Lake Michigan. In addition to the importance of these waters to the industrial complexes along the shores of Wisconsin, Illinois, Indiana, and Michigan, the Federal Government needed information to protect the interests of the United States in cases pending before the Supreme Court. Four cases on the subject of diversion and water reserves of Lake Michigan are before a Special Master appointed by the Supreme Court. The United States is a party to these cases on its own motion because of the extensive national interests and treaty obligations involved.

In the late winter of 1960, the Solicitor General urgently requested the Department of Health, Education, and Welfare to undertake a study to develop information to protect the interests of the United States and assist the Special Master. Studies for this purpose of lower Lake Michigan and the Illinois waterway have been made. Reports have been prepared, and the Director of the Great Lakes - Illinois River Basins Project has presented the material and expert testimony to the Special Master at this time.

Much is yet to be learned; but the controversy over the diversion of water at Chicago has gone on since the turn of the century. For the first time, at least some of the decisions can be made on the basis of tangible facts where only speculation or gross estimates existed before. The Public Health Service will continue to provide assistance to the Justice Department until the cases are settled.

To support the initial studies, a laboratory was established at Chicago. From that base the information needed for the Justice Department was assembled. In addition, the basic investigations needed to develop a comprehensive program have progressed. The Illinois River Basin was studied in detail. From those laboratory, engineering, economic, and other scientific investigations, recommendations are being made to abate existing pollution and prevent future deterioration of water quality in the Illinois Basin.

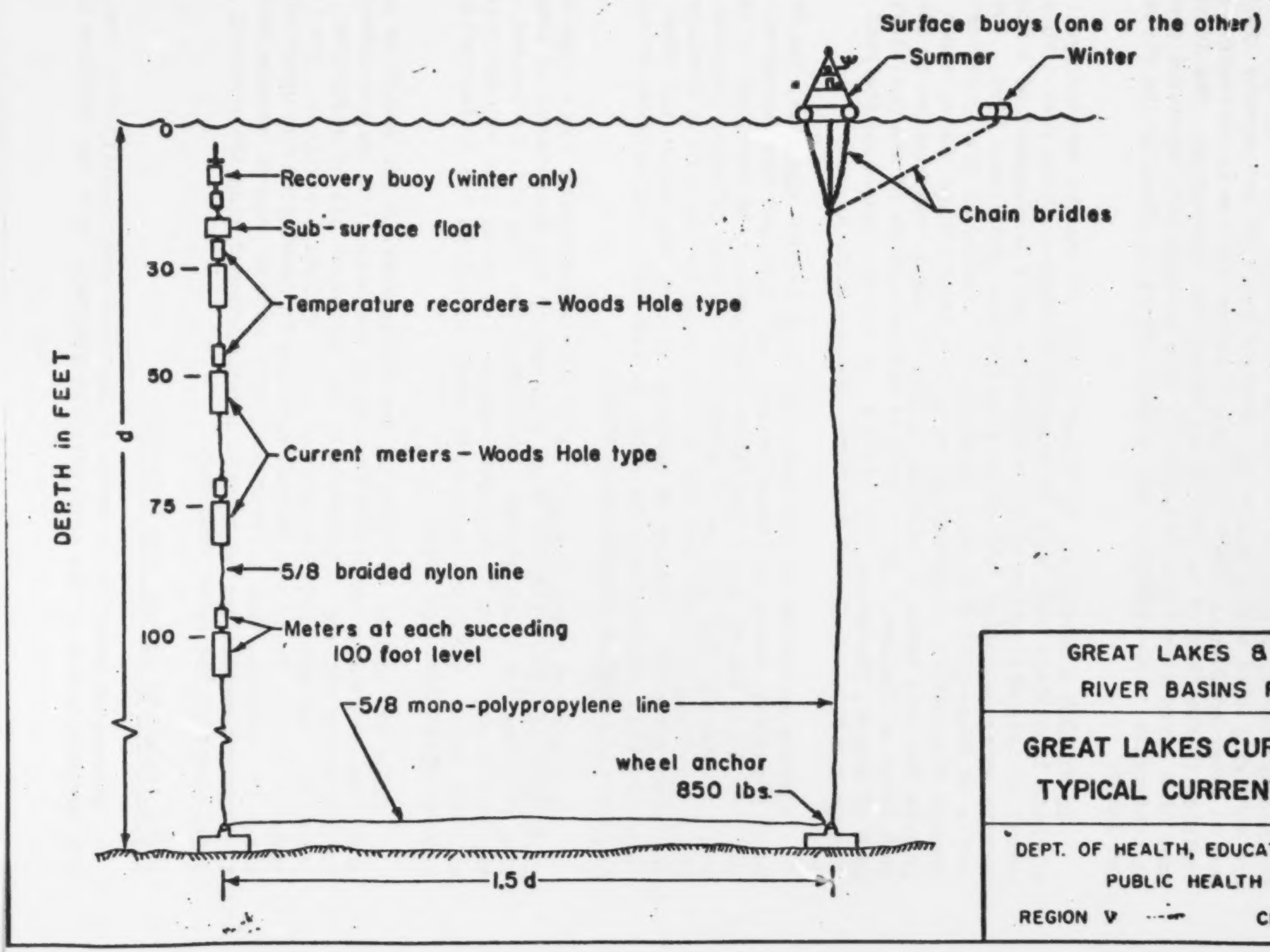
A start has also been made on a study that will eventually fill many gaps in knowledge of the behavior of the Great Lakes. Early in the formulation stage, it was recognized that fundmental facts concerning the distribution of lake currents and the mass movements of waters in the lakes would be needed as a basis for a water pollution control program. Automatic current measuring instruments have been installed in Lake Michigan to continuously record scientific data at various depths. This is the first time that instruments of this type have been used in a lake. The sensitive recording devices will measure currents, wind, temperature and related environmental conditions; and store the information for several months on photographic film. A data processing scheme has been perfected to translate the millions of bits of information of the firm directly to magnetic tape for feed to the oceanographic computer at New York University.

A field station has been opened at Cleveland, Ohio, to support studies in Lake Erie and its drainage basin. Heavy pollution entering Lake Erie is causing the lake to "age" rapidly. Algae growth is profuse, dissolved oxygen drops to zero at times in some parts of the lake, many bathing beaches have been closed, and the fish population has changed to rough·fish. The studies of Lake Erie are being coordinated with scientific institutions in Canada. The Corps of Engineers, the Fish and Wildlife Service, the Great Lakes Fisheries Commission, and State and local agencies are participating in the studies.

In accordance with the study plan, investigations are soon to proceed to Huron, Ontario, and Superior.

Ohio River Basin - In the fall of 1962 a comprehensive water pollution control program was begun in the upper Ohio River Basin with a limited budget of $100,000. These funds permitted the establishment of a field station at Wheeling, West Virginia and the recruitment of key personnel. In 1963 this activity was intensified and another field station opened at Evansville, Indiana.

The Ohio Basin area, particularly the upper portion, is in the industrial heartland of America and contains some of the nation's greatest unsolved pollution problems. These include widespread acid mine drainage as well as


Surface buoys (one or the other)
Summer
Winter
Chain bridles
0
Recovery buoy (winter only)
Sub-surface float
30
Temperature recorders – Woods Hole type
50
Current meters – Woods Hole type
75
5/8 braided nylon line
100
Meters at each succeding 100 foot level
5/8 mono-polypropylene line
wheel anchor 850 lbs.
DEPTH in FEET
d
1.5 d

GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

GREAT LAKES CURRENT STUDY
TYPICAL CURRENT STATION

DEPT. OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V — CHICAGO, ILLINOIS

industrial and municipal waste discharges. A major portion of the Upper Ohio River Basin has been classified as an economically depressed area. The removal of acid from the waterways will restore vast quantities of water for municipal and industrial uses and could be a key to revitalized industrial development. The area is endowed with natural assets to provide recreation for nearby heavily populated regions of the nation. However, many streams are so highly acid that fishing and recreational uses are severly limited. Due to water pollution, there has been a steady decline in recreation opportunities in the face of an increasing demand for recreation. The development of a large recreation industry in this economically depressed area is contingent on an immediate and sizable effort to clean up its streams and lakes.

In FY 1965 a laboratory in Wheeling will be staffed and equipped, and a mobile laboratory unit will be acquired to support field work. This will permit an intensification of investigations and a development of a comprehensive water pollution control program for the upper basin area. The field office at Evansville will be responsible for studies in the lower basin. At present this office is concentrating on the Wabash River Basin, since a program for this basin is urgently needed to supply information to the U. S. Army Corps of Engineers and to fulfill the obligation of the Secretary, Department of Health, Education, and Welfare, to provide advice on the need for storage for flow regulation for water quality control.

Working arrangements have been made with Federal agencies; the State Water Resources, Water Pollution Control, and Fish and Game agencies; and the Ohio River Valley Water Sanitation Commission. An inventory of waste water discharges, and sources of acid mine drainage is being prepared. Data for projections of water uses and likely areas for recreation development are being gathered. Working in cooperation with the States and other Federal agencies, high priority will be given to systematic restoration of water quality in potential recreational areas.

Southeastern River Basins - In FY 1964 appropriated funds permitted initiation of investigations which will lead to the development of comprehensive programs for these basins. Activities for 1964 will be focused upon the recruitment of staff, the development of a study plan and the collection of basic data. The first area to be studied will be the Apalachicola-Chattahoochee-Flint drainage basin.

While the quality of water in the Southeastern River Basins is generally good, the increasing industrialization of the area with the concurrent growth in population centers, together with the increased use of pesticides, toxic chemicals, and nutrients has created water pollution problems. The increasing tempo of local, State and Federal agencies in developing the water resources makes it essential that a water pollution control program receive attention if quality problems are to receive consideration during the planning and development of the water resource.

Accomplishments in Reducing Pollution

Widespread benefits in terms of improved water quality will result from the implementation of the comprehensive programs, once the planning has been completed. It is difficult to assess improvements in water quality resulting from existing projects which are still in the planning stage. However, it seems apparent that even during the early planning stages the studies and activities of the projects have achieved results. Project staffs have emphasized the need for pollution control and provided findings and an impetus which has often resulted in pollution abatement on a voluntary basis or enabled State and local authorities to achieve compliance where resistance occurred previously.

The Arkansas-Red River Basin Project, for which the initial plan has been completed, is the farthest advanced of the six comprehensive programs under way, and it best demonstrates the results which can be obtained through basin water quality planning. Many beneficial effects of this Project are already discernable. For example, shortly after the Project was initiated, the operators of the Oklahoma City oil field voluntarily discontinued the practice of discharging more than 1,000 tons of sodium chloride per day into the North Canadian River. These brines are now being returned to the deep underground oil producing zones. In North Texas, the impetus toward brine pollution abatement provided by the Federal project helped the State and local authorities to remove more than 15,000 oil brine storage ponds over a period of three years. The brines are also being reinjected into oil production zones below fresh water aquifers.

Implementation of the comprehensive water quality control program developed for the Arkansas and Red River Basins will result in even greater benefits. The findings of the study will permit the design of engineering works for the control of natural sources of brine pollution, the largest contributor of salt pollution in the area. The removal of 90 percent of the chloride content now present will enable the development of these waters (amounting to over 30 million acre feet annually at the Arkansas State line) for a great variety of purposes, either not now served or not now possible, because of the present poor quality of the water. This will provide for future population, agricultural, and industrial growth in this naturally water-short region. Similar widespread social and economic benefits resulting from improved opportunities for water use can be expected in other regions as comprehensive programs are completed and put into effect.

DETERMINATION OF MUNICPAL AND INDUSTRIAL WATER SUPPLY AND WATER QUALITY CONTROL NEEDS IN FEDERAL MULTIPLE-PURPOSE RESERVOIRS

Determination of the need for reservoir storage to provide for water quality control and municipal and industrial water supplies is a major portion of the task of preparing a comprehensive river basin program. Closely related to the comprehensive basin studies is the planning which the Public Health Service does in connection with specific water resource development projects of the Federal construction agencies, including those in basins where the preparation of comprehensive quality control programs is not yet under way.

In recognition of the growing need to provide for future municipal and industrial water supply needs as a function of Federal multiple-purpose river basin development, Title III of the Flood Control Act of 1958 (P.L. 500) authorized the Corps of Engineers and the Bureau of Reclamation, in connection with the planning and construction of reservoirs, to include provisions for storage of water on a reimbursable basis to meet future municipal and industrial water supply needs. In 1962, the Watershed Protection and Flood Prevention Act (P.L. 566) was amended to make this provision applicable to the Small Watershed Projects planned by the Department of Agriculture in cooperation with local interests, as well.

The role of the Public Health Service has been one of assistance to the Federal construction agencies in the determination of future water supply needs. In November 1958, a memorandum of understanding was entered into between the Secretary of the Army and the Secretary of the Department of Health, Education, and Welfare, under which the Public Health Service agreed to provide the Corps of Engineers with technical advice and assistance in determining the need for, and the amount and value of such municipal and industrial water supply requirements in connection with Corps of Engineers water resource projects. Similar planning is being conducted by the Public Health Service in connection with Bureau of Reclamation projects in some regions.

One hundred and fifty-six reservoir projects of the Corps of Engineers and the Bureau of Reclamation have been examined for present and future need for and value of storage for municipal and industrial water supply purposes. The annual value of water needs determined in connection with studies completed to date is estimated at $32,016,000. These planning studies are conducted on the basis of reimbursement funds provided by the Corps of Engineers and Bureau of Reclamation.

The 1961 Amendments to the Federal Water Pollution Control Act further broadened the functions of multiple-purpose river basin development by providing for the storage of water in Federal reservoirs for the purpose of stream flow regulation for water quality control. Since the passage of the enabling legislation, 100 reservoir projects have been examined relative to the need for and value of such storage. The annual value of water stored for this purpose in projects already studied is estimated at $11,756,000. In general, these studies have been conducted on the basis of reimbursement funds provided by the Federal construction agencies, except in some cases where the studies could be conducted as a part of comprehensive project activities in regions where comprehensive projects are under way. The President's FY 1964 budget for the Public Health Service proposes an appropriation for the conduct of these studies.

A list of completed studies for the determination of storage requirements for municipal and industrial water supply and stream flow regulation for water quality control is shown in the following table. Studies on a large number of additional reservoir projects are currently under way.

Determination of Municipal and Industrial
Water Supply and Water Quality Control Needs
In Federal Reservoirs - Completed Reports

No.	Project Name	State	Construction Agency 1/
1	East Brimfield & Westville Res.	Conn.	C.E.
2	Fox Point Res.	Penna.	C.E.
3	#2 Barren Res.	Ky.	C.E.
4	Coal River Basin	W. Va.	C.E.
5	Guyandot R. Basin	W. Va.	C.E.
6	John W. Flannagan Res.	Va.	C.E.
7	Laurel River	Ky.	C.E.
8	Licking R. (Cave River Res.)	Ky.	C.E.
9	Little Sandy and Tygarts	Ky.	C.E.
10	New Hope Res.	No. Car.	C.E.
11	N. Fork Pound Res.	Ky.	C.E.
12	Twelve Pole Creek	W. Va.	C.E.
13	Wilkesboro Res.	No. Car.	C.E.
14	Carters Dam	Ga.	C.E.
15	Okatibbee Creek	Miss.	C.E.
16	Walter F. George & Columbia Lock & dam	Ala. & Ga.	C.E.
17	Brookville Res.	Ind.	C.E.
18	Caerses Creek Res.	Ohio	C.E.
19	Illinois River	Ill.	C.E.
20	Kankakee River	Ill. & Ind.	C.E.
21	Licking River Basin	Ohio	C.E.
22	Little Calumet River	Ind. & Ill.	C.E.
23	Mid Wabash Basin	Ind. & Ill.	C.E.
24	Rend Lake Res.	Ill.	C.E.
25	Salamonie Res.	Ind.	C.E.

1/ C.E. - Corps of Engineers; B.R. - Bureau of Reclamation

No.	Project Name	State	Construction Agency
26	Scioto River Basin	Ohio	C.E.
27	Cedar Rapids	Neb.	C.E.
28	Chariton River	Iowa	B.R.
29	Goose River	N. Dak.	B.R.
30	Little Blue Unit	Neb.	B.R.
31	Kaysinger Bluff	Mo.	B.R.
32	Miss. Headwaters	Minn.	C.E.
33	Devils Lake	N. Dak.	B.R.
34	O'Neill Unit	Neb.	B.R.
35	Perry Reservoir	Kan.	C.E.
36	Saylorsville Res.	Iowa	B.R.
37	Bayou Dorcheat	Ark.	C.E.
38	Beaver Res.	Ark.	C.E.
39	Benbrook	Tex.	C.E.
40	Benton	Ark.	C.E.
41	Broken Bow Res.	Oklahoma	C.E.
42	Cooper Reservoir	Tex.	C.E.
43	Cuero Reservoir	Tex.	C.E.
44	Cypress Bayou	Okla.	C.E.
45	Cypress Creek	Tex.	C.E.
46	DeGray Res.	Ark. La.	C.E.
47	Eleven Point Res.	Ark. 1	C.E.
48	Gillham Res.	Ark.	C.E.
49	Grand & Cottonwood	Kan.	C.E.
50	Holiday Creek	Tex.	C.E.
51	Hugo Tuskahoma & Clayton	Okla.	C.E.
52	Kaw Dam	Okla.	C.E.
53	Keystone Res.	Okla.	C.E.
54	Lake Kemp	Tex.	C.E.
55	Laneport, Somerville & Stillhouse	Tex.	C.E.
56	Lavon Res.	Tex.	C.E.
57	Lee Creek	Ark.	C.E.
58	Little Cypress Res.	Tex.	C.E.
59	Marion & Cedar Point	Kan.	C.E.
60	Mullican Res.	Tex.	C.E.
61	Millwood Res.	Ark.	C.E.
62	Mountain Park	Okla.	C.E.
63	Optima Res.	Okla.	C.E.
64	Palmetlo Bend	Tex.	C.E.
65	Pecan Bayou	Tex.	C.E.
66	Pine Creek	Okla.	C.E.
67	Sand-Copan, Birch	Okla.	C.E.
68	Sanders Big Pine	Tex.	C.E.
69	San Gabriel R.	Tex.	C.E.
70	Shidler Res.	Okla.	C.E.
71	S.E. Okla. and S.W. Ark.	Okla. - Ark.	C.E.
72	Trinity River	Tex.	C.E.

No.	Project Name	State	Construction Agency
73	Wallisville Res.	Tex.	C.E.
74	Walnut River B.	Kan.	C.E.
75	White Oak Creek	Tex.	C.E.
76	Animas-LaPlata	Colo.	B.R.
77	Bear River	Utah	B.R.
78	Bostwick Park	Colo.	B.R.
79	Curecanti Unit	Colo.	B.R.
80	Dolores Project	Colo.	B.R.
81	Lyman Project	Wyo.	B.R.
82	Silt Project	Colo.	B.R.
83	Dry Creek Project	Calif.	B.R.
84	Kellogg Res.	Calif.	B.R.
85	San Francisco Barrier	Calif.	B.R.
86	Kennewick Div. Ext.	Wash. - Ore.	B.R.
87	Mill Creek	Ore.	C.E.
88	Monmouth-Dallas	Ore.	B.R.
89	Rogue River	Ida.	C.E.
90	Touchet	Wash.	B.R.
91	Tualatin	Ore.	B.R.
92	Wynoochee Project	Wash.	B.R.
93	Green River Res.	Ky.	C.E.
94	Potomac R. Basin	Md. & Pa.	C.E.
95	Carter Is-Goat Is	Ga. SC	C.E.
96	Pearl-Big Black RB	Ala. Miss.	C.E.
97	Tenn. Tombigbee	Ala. Miss.	C.E.
98	Laurel Dam	Ky.	C.E.
99	Trindad Reservoir	Colo.	B.R.
100	Marble Canyon	Ariz.	B.R.
101	Bridge Canyon	Ariz.	B.R.
102	Blanchard	Penn.	C.E.
103	Canaserga	N.Y.	C.E.
104	Shelbyville	Ill.	C.E.
105	Des Moines R.	Iowa	C.E.
106	Green River	N. Dak.	B.R.
107	Little White Res.	S. Dak.	B.R.
108	Waurika	Okla.	C.E.
109	Juniper	Colo.	C.E.
110	Alamo Res.	Ariz.	C.E.
111	St. Francis	Ark.	C.E.
112	Dixie Project	Utah	C.E.
113	Emery County Unit	Utah	B.R.
114	Fruitland Mesa	Colo.	C.E.
115	Flint River Lake Seminole	Ga.	C.E.
116	Ochlockonee Basin		C.E.
117	Souris River	N. Dak.	C.E.
118	West Thompson Res.	Conn.	C.E.
119	Lower Roanoke	Va. & NC	C.E.
120	Arbuckle	Okla.	C.E.

No.	Project Name	State	Construction Agency
121	Mangum	Okla.	C.E.
122	Little Sandy River	Ky.	C.E.
123	Fire Island Inlet	N.Y.	C.E.
124	Two Bridges Res.	N.J.	C.E.
125	Walnut River	Kan.	C.E.
126	Central Utah Proj.	Utah	C.E.
127	Eel River	Calif.	C.E.
128	Big Sandy	W. Va. & Ky.	C.E.
129	Boysen Modification	Wyo.	B.R.
130	Weiser River Proj.	Ida.	B.R.
131	Willow Creek Heppner Reser.	Ore.	C.E.
132	Texas Basins	Tex.	C.E.
133	French Creek	Penn.	C.E.
134	Price River Basin	Utah	C.E.
135	Cooper Reservoir	Tex.	C.E.
136	Bayou Teche	La.	C.E.
137	Pembina River	N. Dak.	C.E.
138	Kenneconick Crk.	Ky.	C.E.
139	Willapa River B.	Wash.	B.R.
140	Town Creek	Ga.	C.E.
141	Jamaica Bay	N.Y.	C.E.
142	Pine Ridge Unit	N. Dak.	B.R.
143	Ruedi Dam & Reser. Frying Pan - Ark	Colo.	B.R.
144	Pend Orielle Project	Wash.	B.R.
145	Umpqua River Basin Dalla R.B.	Ore.	B.R.
146	Catherine Creek and Lower Grande Ronde Res.	Ore. - Wash.	B.R.
147	Dayton Reservoir Walla Walla R.B.	Wash. - Ore.	B.R.
148	Salmon Falls Proj.	Ida.	B.R.
149	Dallas Creek	Colo.	B.R.
150	Woodbine Reservoir	Kan.	C.E.
151	Russian River Proj.	S. Francisco	C.E.
152	East Fork Reservoir	Ohio	C.E.
153	Caesar Creek	Ohio	C.E.
154	Rogue River	Ida.	B.R.
155	Grand R.B.	Iowa & Mo.	C.E.
156	Whiteoak Creek R.B.	Ohio	C.E.

BASIC DATA ACTIVITIES

Basic data are to water pollution control what vital statistics are to health and what bookkeeping and inventories are to business. In pollution control, basic data mean the necessary information on the sources, kinds, and amounts of pollutants; the causes and effects of this pollution on water quality and uses; the present and future needed uses of waters; the kinds, costs, and effectiveness of treatment facilities; the costs and benefits associated with pollution control; and related engineering, scientific, and economic information. Basic data are essential to the making of sound decisions in the overall national water pollution control program and become increasingly important as the competition for the fixed supply of water grows, and as the value of this water and the costs for its conservation and quality maintenance rise.

The lack of necessary and reliable basic data on pollution and its effects on the Nation's waters has been of serious concern to Federal water resources commissions and committees established by the Congress and the Executive Branch. The first major recommendation of the 1955 Presidential Advisory Committee on Water Resources Policy was that the then Federal basic data program be tripled over a period of five years. This concern was also strongly expressed at the Congressional hearings on the bill which became the 1956 Federal Water Pollution Control Act. Consequently, one of the major provisions in the Act called for the collection and dissemination of basic data on physical, chemical and biological water quality, and other information related to the cause, prevention and control of water pollution. Since that time, other major committees and conferences have directed their attention to the need for better basic data in making water quality management decisions.

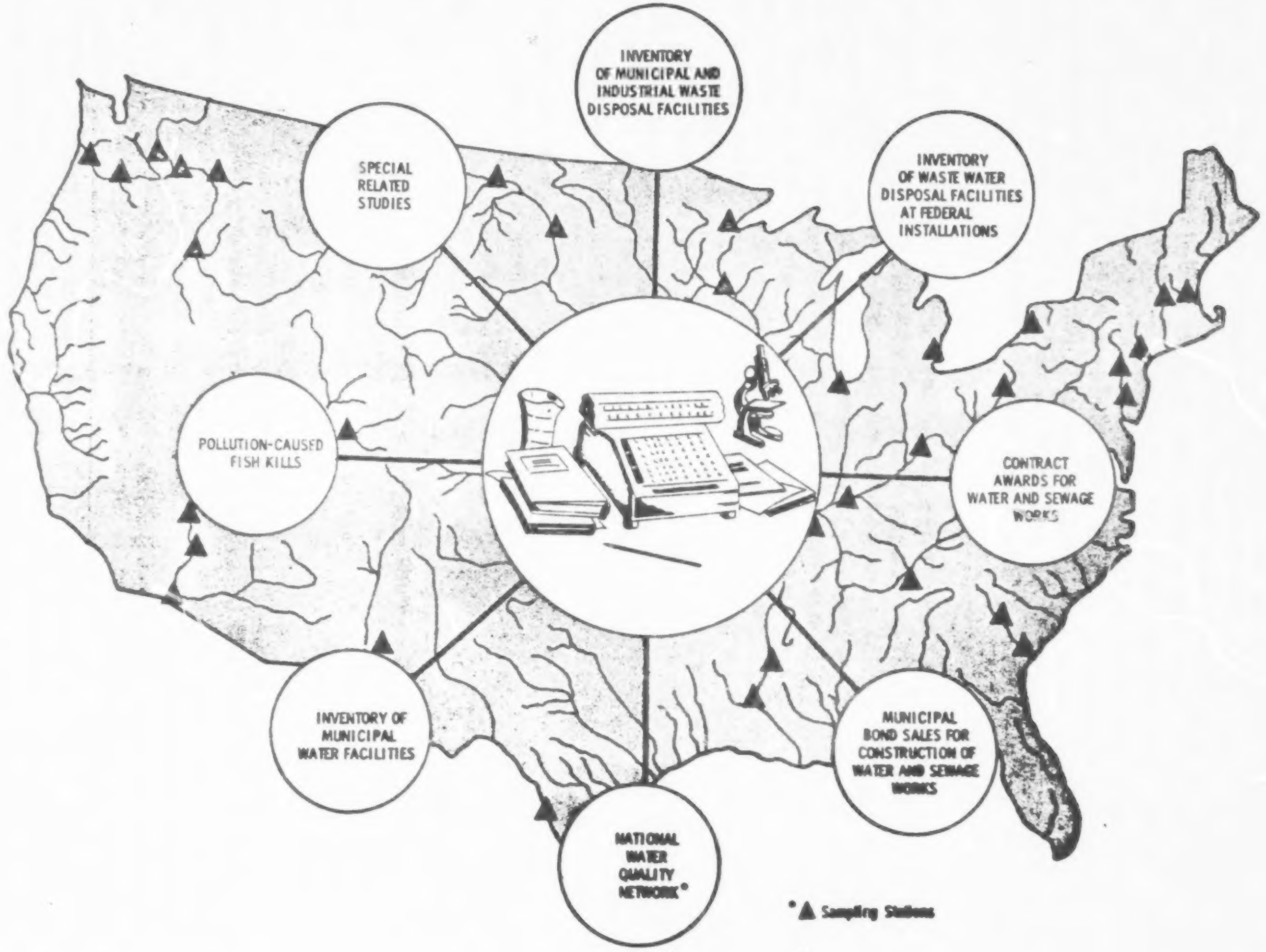
Funds Appropriated - Funds appropriated under the Federal Water Pollution Control Act for basic data activities have been as follows:

Fiscal Year	Amount	Fiscal Year	Amount
1957	$300,000	1961	$ 793,611
1958	500,000	1962	1,193,502
1959	555,000	1963	1,252,000
1960	573,202	1964	1,347,000

Use of Appropriated Funds - The Public Health Service has collected or assisted in the collection of basic inventory data on water and sewage facilities for over 40 years. In 1937, the Conference of State Sanitary Engineers requested the Service to take over this operation with the States supplying the data and the Service compiling and publishing these data, and preparing statistical analyses of them. In 1953 a special inventory of water supply facilities was compiled to meet mobilization planning needs. In response to requests, and to meet needs of the Department of Commerce, additional water facilities inventories were compiled in 1954, 1955 and 1956. Inventory activities were irregular and generally undertaken to meet special needs.

Following passage of the Federal Water Pollution Control Act, a continuing and much more comprehensive program of basic data collection, evaluation, and dissemination has been planned that is being programmed as rapidly as

BASIC DATA
Collection, Evaluaton & Dissemination


INVENTORY OF MUNICIPAL AND INDUSTRIAL WASTE DISPOSAL FACILITIES
SPECIAL RELATED STUDIES
INVENTORY OF WASTE WATER DISPOSAL FACILITIES AT FEDERAL INSTALLATIONS
POLLUTION-CAUSED FISH KILLS
CONTRACT AWARDS FOR WATER AND SEWAGE WORKS
INVENTORY OF MUNICIPAL WATER FACILITIES
MUNICIPAL BOND SALES FOR CONSTRUCTION OF WATER AND SEWAGE WORKS
NATIONAL WATER QUALITY NETWORK*
*▲ Sampling Stations

BASIC DATA ARE REQUIRED FOR THE INTELLIGENT PLANNING AND MANAGEMENT OF WATER POLLUTION CONTROL PROGRAMS resources permit. The objective of the program is to provide reliable information regarding the status of municipal water supply and sewage treatment facilities throughout the country, the financing and construction of new and improved facilities, the quality of the Nation's surface waters, and related basic information. A corollary objective of the program is the development and perfecting of methods and equipment for collecting and disseminating such information.

The program embraces three general areas of activity: (1) collection of inventory data; (2) collection of economic data; and (3) collection of water quality data. Paralleling these activities are, of course, the evaluation and dissemination of the collected data.

Inventory Data - Inventory activities include the regular and continuing collection, evaluation and publication of data on municipal and industrial waste treatment facilities, municipal water facilities, waste water disposal at Federal installations, and pollution caused fish kills.

These inventories are used by a number of agencies and organizations both governmental and private. A principal use is in Federal comprehensive program planning on a regional basis for water quality control. A complete inventory of all facilities within a comprehensive project area is a basic requirement for such planning. The Corps of Engineers and the Bureau of Reclamation also use these inventories in their water resources planning projects and in preparation of reports to the Congress. They are also used in the health mobilization activities of the Public Health Service, and in the mobilization readiness planning of the Department of Defense.

The inventories are used by the U. S. Geological Survey as supplements to their data. In the Department of Commerce, they are used as a guide to materials requirements for the water and sewage industries, and as a guide to allocation of materials. State and municipal officials use them to review practices in other States and communities, and as a measure of progress within their own State. Equipment manufacturers use them frequently as marketing guides, and consulting engineers find source material on practices and needs. Thus, a wide variety of needs are met by the availability of these up-to-date inventories of municipal water and waste facilities.

Periodic revisions of these inventories are made from data supplied by the States, and are published in printed form for distribution to the States and others. Punched card techniques and modern tabulating equipment are used in their preparation. Future inventory information will be tabulated and analyzed using digital computer operations and programming. The status of each of these inventories is as follows:

1. Municipal and Industrial Waste Treatment Facilities Inventory -This inventory is published in nine volumes at 5-year intervals. Each volume contains the inventory information from States within the specific administrative region of the Department. Separate publications for each State are also available. The initial inventory, containing data as of January 1, 1957, is in wide usage. The January 1, 1962, revision was completed and distributed by the end of 1963. It differs from the 1957 inventory in that it contains information on municipal wastes only for reasons subsequently discussed.

In addition to the regional volumes on waste treatment inventory facilities, the tabulating machine operations make it possible to meet requests by State agencies, or other organizations for special listing. These can be provided on short notice by State, river basin area or other geographic measure, as well as by type of treatment facility or other category of information contained in the inventory. The use of computer techniques makes relatively easy the undertaking of special studies, the need for which may not have been foreseen when the original data was compiled.

2. Municipal Water Facilities Inventory - This inventory is also published every five years. It contains the latest information on all municipal water supply facilities serving 100 persons or more. The first such inventory was published as of January 1, 1958, and is also in nine volumes covering the Department regions. In addition to containing information about each water supply facility, listed alphabetically by city within each State, there is a listing of towns within that State having no public water supplies.

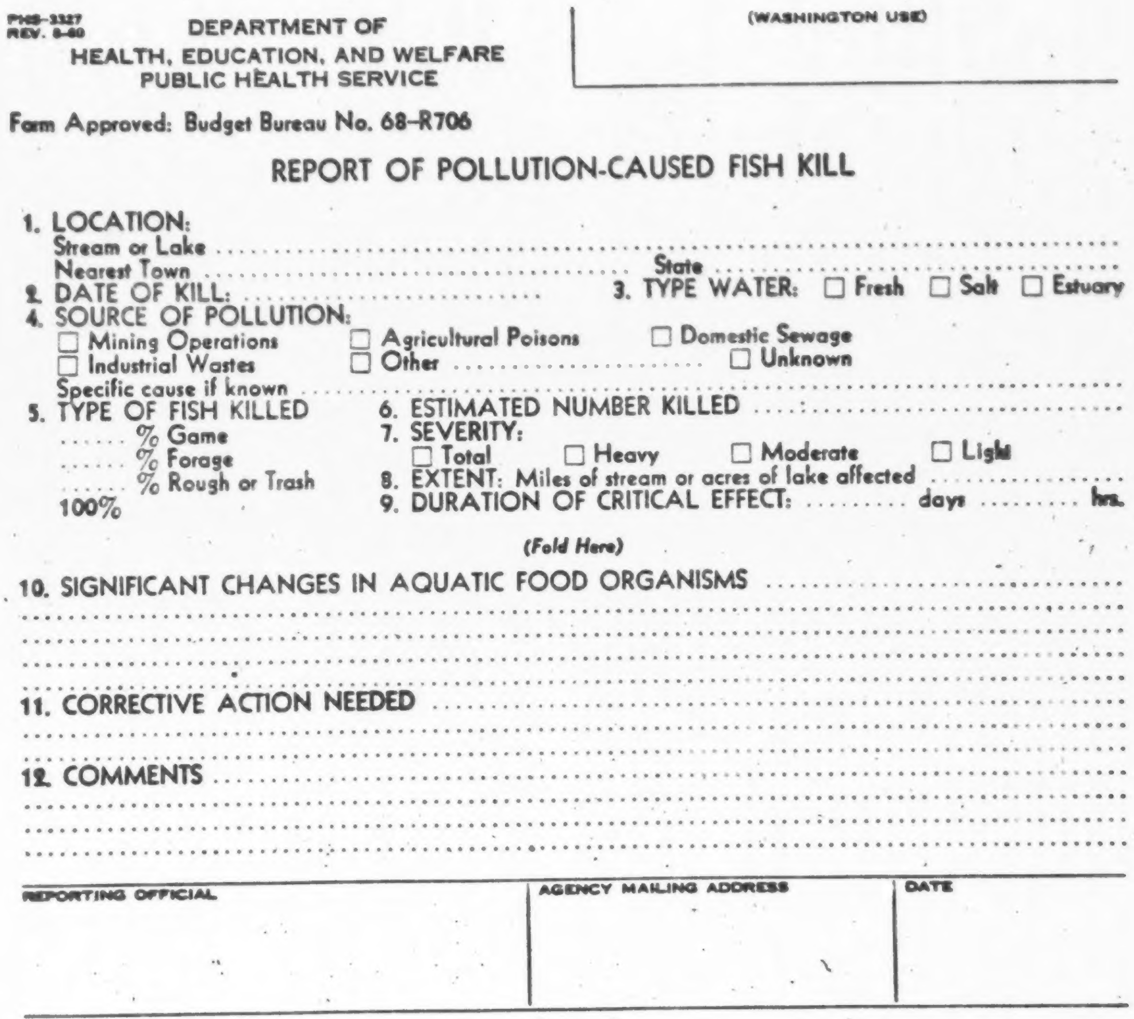
Data for the second edition of this inventory is now being collected. When published it will reflect conditions as of January 1, 1963. The digital computer is being used to process this inventory, and subsequent special listings or requests for analyses can accordingly be expeditiously made.

The publication, "Municipal Water Facilities, Communities of 25,000 Population and Over," first published in 1954 on request for additional information on public water supplies, is now being published bienially since 1958. Separate volumes containing statistical summaries accompany each biennial inventory.

3. Inventory of Waste Water Disposal Practices at Federal Installations - A more complete discussion of this project is contained elsewhere in this report. It is mentionad here to illustrate the capability of the inventory collection program to meet a special request for a particular purpose. The mechanisms and specialized techniques of the inventory collection program made possible the undertaking of this major project with relatively little difficulty. In 1960 the President directed that an inventory of every Federal facility in the country be compiled to determine their manner and method of disposal of wastes to provide a basis for the Federal Government to take the lead in controlling water pollution. This special inventory, comprising 57 volumes, was published in 1962.

4. Information on Pollution Caused Fish Kills - In early 1960, the Surgeon General asked all State conservation and fish and game agencies to assist him by reporting instances of fish kills attributable to pollutants entering the streams or lakes of the Nation. In addition to their statistical value, these data provide a special qualitative measure of biological water quality. Existing surveillance procedures were to be used in gathering the information. A self-addressed postcard reporting form, devised in cooperation with the U. S. Fish and Wildlife Service and independent conservation organizations, is used for this purpose (Fig. 1). The response has been enthusiastic.

The fish kill reporting activity has completed its third year of operation. As the reporting authorities in the States become accustomed to furnishing more complete information about each kill, the resulting publications



PHS-3327
REV. 8-60

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE

(WASHINGTON USE)

Form Approved: Budget Bureau No. 68–R706

REPORT OF POLLUTION-CAUSED FISH KILL

1. LOCATION:
Stream or Lake ....
Nearest Town .... State ....
2. DATE OF KILL: .... 3. TYPE WATER: ☐ Fresh ☐ Salt ☐ Estuary
4. SOURCE OF POLLUTION:
☐ Mining Operations ☐ Agricultural Poisons ☐ Domestic Sewage
☐ Industrial Wastes ☐ Other .... ☐ Unknown
Specific cause if known ....
5. TYPE OF FISH KILLED
...... % Game
...... % Forage
...... % Rough or Trash
100%
6. ESTIMATED NUMBER KILLED ....
7. SEVERITY:
☐ Total ☐ Heavy ☐ Moderate ☐ Light
8. EXTENT: Miles of stream or acres of lake affected ....
9. DURATION OF CRITICAL EFFECT: .... days .... hrs.

(Fold Here)

10. SIGNIFICANT CHANGES IN AQUATIC FOOD ORGANISMS ....

11. CORRECTIVE ACTION NEEDED ....

12. COMMENTS ....

REPORTING OFFICIAL	AGENCY MAILING ADDRESS	DATE

Figure I

will become more meaningful and serve as a more useful tool in helping to identify and abate pollution. So far it has served as a powerful stimulus in consolidating public opinion against the discharge of wastes into surface waters used for recreational purposes.

Economic Data - Economic data includes information on construction activity in the water works and sewage treatment field as measured by the sale of municipal bonds to finance such works and by contract awards for such construction. It also includes studies of unit costs, the relationship between costs and corresponding benefits, costs of operation and maintenance of sewage treatment plants, and similar information. The bond sales and contract awards data provide a sound method of measuring the rate at which water and sewage facilities construction is proceeding. Coupled with estimates of national requirements based on population growth and other factors, these data give an excellent measure of the adequacy of construction activity. Such data provide a basis for judging the rate at which needed facilities are being financed and constructed, and are useful to those industries which service the water supply and sewage treatment field. Special analyses of these data, published periodically, are widely used.

The economic data collection activity falls logically into three groupings: (1) municipal bond sales for water supply and sewage treatment facilities; (2) contracts awarded for construction of these facilitis; and (3) special studies of related aspects, such as unit costs, operation and maintenance costs, cost-benefit analysis, and construction put-in-place.

1. Municipal Bond Sales for Water Supply and Sewage Treatment Facilities - Under a contract negotiated in 1959, the Investment Bankers Association furnishes the Basic Data Branch with monthly information on the sale of municipal bonds for water supply and sewage facilities. The information includes dollar volumes of bonds sold, date of sale, type of political sub-division, type of bond (general obligation or revenue), and interest rate. The volume of bond sales is indicative of the volume of contracts to be awarded, a rise or decline in bond sales usually being followed by a corresponding rise or decline in contracts awarded.

These data are published annually in PHS Publication No. 837, entitled, Water and Sewer Bond Sales in the United States. The first issue is dated 1959. In addition to the annual publication, a monthly tabulation of the dollar volume of bond sales, showing the volume and net interest cost by category, is prepared. A cumulative monthly list of the individual bond sales with selected descriptive data is furnished to each State.

2. Contract Awards for Sewerage and Water Works Construction - Information on sewage treatment plant contract awards was first published in PHS Publication No. 633, Sewage Treatment Works Contract Awards 1952-1957. Since 1957, data on contract awards for water works and collecting sewers have been included. In the resulting publication, Sewerage and Water Works Construction, it has been possible to provide a more detailed summarization and analysis than the earlier documents through use of a digital computer and punch card machine tabulating equipment. About 25,000 contract notifications in the water and sewage works construction fields are processed annually. These data are furnished by the F. W. Dodge Corporation for the 37 eastern States, the Construction Daily Reports of McGraw-Hill Company, and various construction

news periodicals such as Construction News Bulletin, Pacific Architect and Builder, Rocky Mountain Construction, and Southwest Builder and Contractor.

An annual tabulation of sewage treatment works contract awards by State is also published.

3. Special Related Studies - Numerous special studies of the inventory and economic information collected by the Federal program are made in cooperation with other agencies or organizations.

a. Completed Studies:

(1) Cost-benefit Analyses. Several studies have been published showing the relationship between the cost of controlling pollution and the resulting benefits.

(2) Trends in Water and Sewer Bond Sales, 1957-1961. This study, covering a 5-year period, was published in a technical journal.

(3) Municipal Sewage Treatment Needs. Summarization and tabulation of national needs for waste treatment facilities, based on the 1957 inventory of municipal and industrial waste facilities, (PHS Pub. No. 619).

(4) Financing Sewage Treatment Facilities. An analysis of difficulties and recommendations regarding desirable courses of action relating to bond sales in smaller municipalities, (PHS Pub. 886).

(5) Per Capita Cost of Sewage Treatment Plant Construction. An analysis of such costs for various design populations and for different types of treatment. Published in a technical journal.

b. Studies Under Preparation:

(1) Assessment of Bomb Damage to Public Water Supplies. Under a contractual agreement with the Department of Defense, the Basic Data Branch is conducting a survey of all public water supply systems in the United States. The objective is to provide a means for assessing probable damage to critical elements of these water supply systems likely to result from enemy attack by nuclear weapons, including loss of capacity. Digital computer tabulations of the analyses will be furnished to the National Resources Evaluation Center (an agency of the Office of the Emergency Planning, Office of the President).

The data in the inventory are based on practice exercises to evaluate probable damage to water systems which would be caused by hypothetical bombs of various sizes dropped at varying distances from the facilities. Print-out estimates of anticipated damage will be available to the President and top officials of the various Federal Departments and agencies at their relocation centers and at other secluded positions, at the time of an actual attack.

(2) Construction Put-in-Place. Levels of construction put-in-place in the water supply and sewerage field offer a more current measure of progress than do contract awards. Tables now used in

estimating construction to be put in place, based on contract awards, are now over 20 years old. Therefore, data available through the Federal construction grants and Accelerated Public Works programs are being used to prepare new projection tables more closely reflecting present construction materials and methods.

(3) Per Capita Cost of Sewage Treatment Plant Construction. An improved study of sewage treatment plant costs, using a much wider base is underway in cooperation with the Federal construction grants program.

(4) Per Capita Cost for Operation and Maintenance of Sewage Treatment Plants. An improved and updated study, based on analyses of plants built under the Federal construction grants program, to be published on a regular schedule.

(5) Water Works Financing, Operational Costs, and Needs. In cooperation with the American Water Works Association, an analysis of 1960 water works operations is being made. The AWWA has circulated a questionnaire to operators of water works serving populations of 2,500 and over. The collected data will be processed and analyzed by the Federal basic data program. Projections of needs and information on per capita operating costs will be developed.

Water Quality Data Collection - Water quality data are concerned with the physical, biological, and chemical constituents of surface waters. The data are derived from repeated sampling of water at selected points along a river course or lake area to establish trends in pollutional loads and their effects on the water body. Developed trends indicate whether progress is being made in water pollution control as a result of construction, regualtions, or enforcement actions.

A vast amount of information concerning the quality of the Nation's surface waters already exists, but is usually located in laboratory files and other records of various Federal, State, and local agencies. Much of it has been gathered for particular studies and has not been collected in conformity with the standards and procedures of a national system and is therefore not comparable. To assist the States in the collection, standardization and dissemination of water quality data, and to meet its own needs and those of other Federal water resources agencies, a National Water Quality Network was established in 1957.

1. National Water Quality Network - The National Water Quality Network is a series of sampling stations located on the major streams of the country, including interstate, coastal, the Great Lakes, and other water bodies in which the Federal government has responsibilities. About 50 stations were established in 1957, in cooperation with State and local agencies. Between 1957 and the present time, the number of stations has been increased to 125. These stations are shown on the accompanying map.

a. Objectives of the National Water Quality Network. The principal objectives of this activity have been: (1) to provide a continuous long-term record of changes in water quality at key points in river systems so that trends can be established; (2) to provide continuous information on pollution affecting water quality and thus providing a water monitor at those points where this is desirable or necessary; (3) to provide data necessary in connection with comprehensive water resources programs, enforcement activities, and special technical projects; and (4) to disseminate data to State and interstate water pollution control agencies.

b. Cooperation and Participation by State and Local Agencies. The successful operation of a Network station requires that samples of water be collected on a routine periodic basis, that some water chemistry tests be made quickly on the spot or in a nearby laboratory, and that samples be sent in to a central laboratory for the more complex analyses. In the selection of each site, these are factors as well as the availability and willingness of a State or local organization to assume responsibility for operating the station. Each station of the Network is operated cooperatively with a State or local agency or industry with a suitable laboratory where the more routine analyses are made. The more complex determinations such as radioactivity, organic chemicals, plankton, and bacteriological tests are made at a central laboratory facility at Cincinnati.

Participants include more than 100 local water, sewerage, or other public utilities, health departments, industries, universities, Federal agencies, and State water pollution control agencies. No funds are exchanged between agencies, and no salaries or other means of compensation are paid to any individuals for their assistance in station operation with the exception at a few remote stations where a nominal mileage fee is paid to the individual who collects the samples.

c. Central Laboratory at Cincinnati. Headquarters for the National Water Quality Network is at Cincinnati, Ohio. The central laboratory there makes those analyses not made at the local stations. Its new quarters are specially designed for the most efficient operation in analyzing the thousands of water samples that must be processed and the laboratory contains the most complete equipment and instrumentation available for the many complex determinations that are routinely made.

As a corollary and necessary service, the National Water Quality Network headquarters also has an Instrumentation and Equipment Development Unit. Many of the stations are equipped with special sampling and filtration equipment for the collection of organic contaminants from the water, while others will be equipped with automatic sampling and analyzing instruments for making certain determinations on a continuous basis. This Unit is responsible for developing the required equipment and instrumentation. Working closely with several instrument manufacturers, it has taken the lead in the development of new measurement equipment.

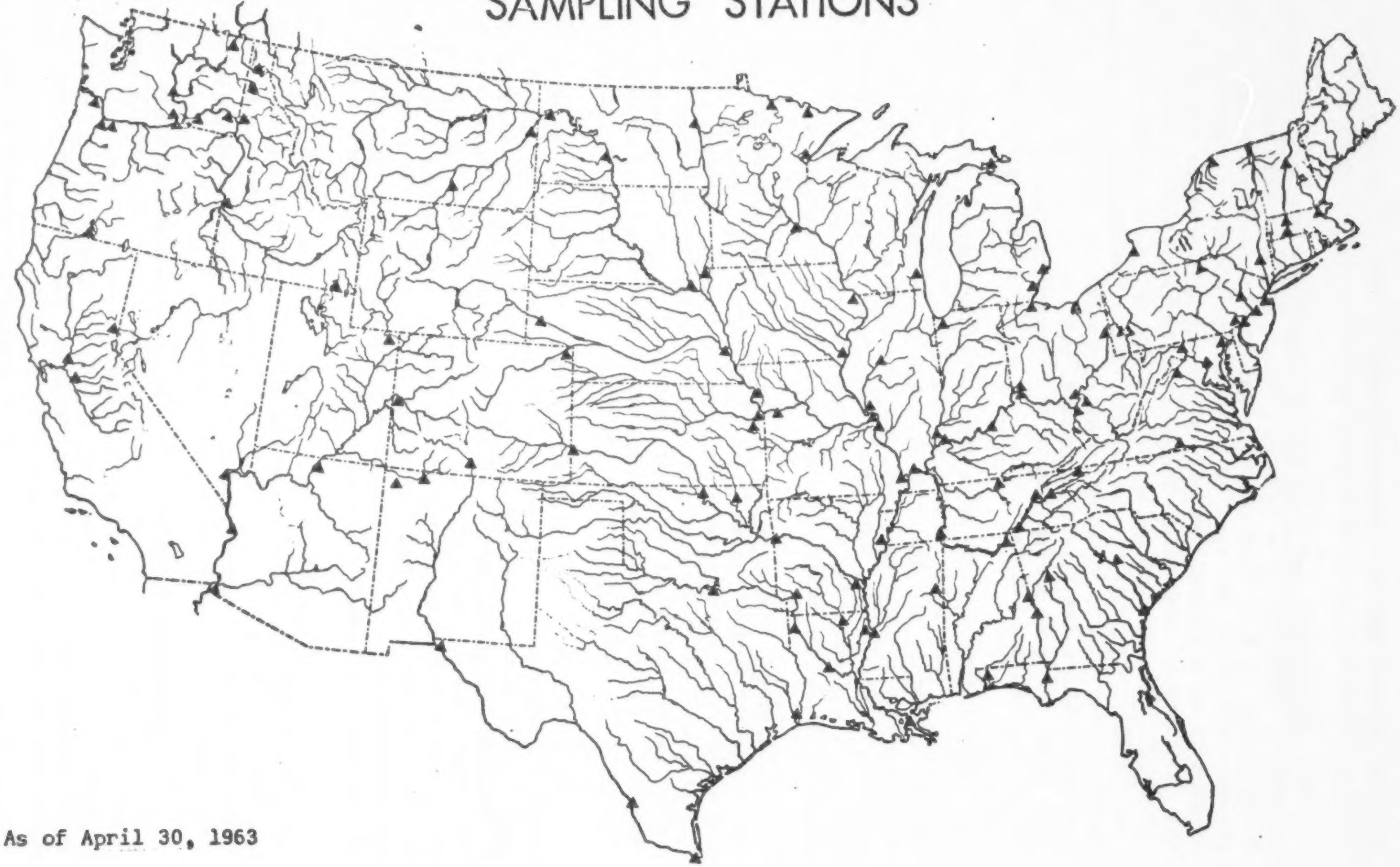
A special headquarters unit devotes full time to the analysis and interpretation of the collected data. Local station cooperators and responsible agencies are notified immediately when sample results indicate unusual circumstances or events involving discharge or larger then usual quantities of water pollutants.

d. Laboratory Measurements. The following measurements are considered to be of the greatest value in meeting the objectives of the Network operation: (1) radioactivity, (2) plankton populations, (3) coliform organisms, (4) organic chemicals, (5) trace elements, and (6) about 15 usual chemical and physical measurements. These are performed on the water samples collected at each Network station.

Radioactivity: Long recognized as a natural contaminant of water, radioactivity continues to grow in importance with the development of nuclear weapons and atomic energy for peaceful purposes. Background levels

PHS National Water Quality Network

SAMPLING STATIONS



As of April 30, 1963

125 Stations (Includes Alaska: Fairbanks)
Anchorage)

Figure 2

Figure 4

PARTICIPATING AGENCIES

- Alexandria Louisiana Water Department
- Aluminum Company of America, Wenatchee, Washington
- Arizona Water Company, Yuma, Arizona
- Arkansas Water Pollution Control Commission
- Atlanta Georgia Water Department
- Baltimore Maryland Water Department
- Bismarck North Dakota Water Department
- Boulder City Nevada Water Department
- Brownsville Texas Water Department
- Buffalo New York Water Department
- Burlington Iowa Municipal Water Department
- Cairo Illinois Water Company
- California-Oregon Power Company
- Chatham County Georgia Health Department
- Cincinnati Ohio Water Department
- City of Farmington, New Mexico
- City of Julesburg, Colorado
- City of Klamath Falls, Oregon
- City of Richland, Washington
- City of Sioux Falls, South Dakota
- City Water Company, Chattanooga, Tennessee
- Clarksville Tennessee Water Department
- Colorado State Department of Health
- Columbus Georgia Water Department
- Columbus Mississippi Light and Water Department
- Columbus Mississippi Y.M.C.A.
- Continental Oil Company, Ponca City, Oklahoma
- Crown Zellerbach Company, Camas, Washington
- Denison Texas Water Department
- Detroit Michigan Water Department
- Dubuque Iowa Water Department
- Duluth Minnesota Water, Gas & Sewage Treatment Department
- East Liverpool Ohio Water Department
- East St. Louis Illinois Water Company
- El Paso Texas Public Service Board
- Erie County New York Health Department
- Evansville Indiana Filtration Plant
- Florida State Department of Health, Pensacola Laboratory
- Florida State Hospital, Chattahoochee
- Fort Smith Arkansas Water Department
- Gary-Hobart Water Company, Gary, Indiana
- General Motors Corporation Aluminum Foundry,
    - Massena, New York
- Grand Forks North Dakota Water Department
- Grand Junction Colorado Water Department
- Hagerstown Maryland Water Department
- Huntington West Virginia Water Corporation
- International Business Machines Corporation,
    - Poughkeepsie, New York
- Kanawha Valley Power Company, Winfield Dam, West Virginia
- Kansas City Kansas Board of Public Utilities
- Klamath County Health Department, Klamath Falls, Oregon
- Laredo Texas Water Works System
- Louisiana State Board of Health, New Orleans
    - Alexandria Regional Laboratory
- Louisiana Wildlife and Fisheries Commission
- Louisville Water Company, Inc.
- Lowell Massachusetts Water Department
- Lowndes County Health Department, Columbus, Mississippi
- Massachusetts Department of Health,
    - Amherst
    - Lawrence Experiment Station
- Memphis Tennessee Light, Gas & Water Division
- Mesa County Colorado Department of Public Health
- Metropolitan Utilities District, Omaha, Nebraska
- Metropolitan Water District of Southern California
- Milwaukee Wisconsin Water Works
- Minneapolis-St. Paul Sanitary District
- Mississippi State Board of Health
- Missouri Utilities Company, Cape Girardeau
- Montana-Dakota Utilities Company, Sidney, Montana
- Nebraska State Department of Health
    - Board of Public Works, Plattsmouth Nebraska
    - West Nebraska Branch Laboratory
- Nevada County Health Department, California
- New Orleans Louisiana Water Purification Plant
- North Augusta South Carolina Water Department
- North Dakota State Department of Health,
    - Public Health Laboratory
- Northeast Colorado Health Department
- Northern States Power Company
- Oklahoma-Mississippi River Barge Lines Company,
    - West Memphis, Tennessee
- Pasco Washington Water Department
- Pennsylvania Power & Light Company,
    - Martins Creek, Pennsylvania
- Peoria Illinois Water Company
- Philadelphia Electric Company,
    - Conowingo Hydro Station, Maryland
- Philadelphia Water Department
    - Belmont Laboratory
    - Torresdale Laboratory
    - Water Quality Control & Research
- Pittsburgh Pennsylvania Water Department
- Ponca City Oklahoma Water & Light Department
- Port Huron Michigan Utilities Department
- Potamological Institute of the University of Louisville
- Sabine River Authority, Orange, Texas
- St. Joseph Missouri Water Company
- St. Louis County Water Company,
    - University City, Missouri
- St. Louis Missouri Water Department
- San Juan County New Mexico Health Department
- Sault Ste. Marie Michigan Water Department
- Sayre Pennsylvania Water Company
- South Pittsburgh Water Company
- Tennessee Valley Authority
    - Division of Health and Safety
    - Office of Power
    - Stream Pollution Laboratory
- Texarkana, Ark-Tex. Water & Sewer Systems
- Union Bag-Camp Paper Company, Savannah, Georgia
- U. S. Army Transportation Corps, Beaver Terminal, Oregon
- U. S. Bureau of Reclamation
    - Boulder City, Nevada
    - Glen Canyon Unit, Page, Arizona
- U. S. Corps of Engineers,
    - Berryville, Virginia
    - Bonneville Dam, Oregon
    - Dalecarlia Filtration Plant, Washington, D. C.
    - Denison Dam, Texas
    - Jim Woodruff Dam, Chattahoochee, Florida
    - John H. Kerr Reservoir & Dam, Virginia
    - Lock & Dam #11, Dubuque, Iowa
    - Lock & Dam #3, above St. Paul, Minnesota
    - McNary Dam, Oregon
- U. S. Geological Survey,
    - Lamar, Colorado
    - West Point, Miss.
- Washington Pollution Control Commission
- Washington State University, Pullman
- West Virginia Water Resources Commission
- Williston North Dakota Water Department
- Yankton South Dakota Water Department

reflecting naturally occurring radioactive substances are being catalogued to provide a basis for determining the pattern of radioactive fallout reaching surface waters from world wide weapons testing. Gross alpha and beta measurements are made on both suspended and dissolved solids and provide a rough measure of the levels which may be found in a treated water, where treatment substantially removes all of the suspended matter.

Plankton Populations: Interesting knowledge has been gained from the study of plankton populations at the Network stations. Many aquatic organisms are sensitive to the various substances which pollute water. Some live only in clean water, while others may be stimulated to multiply by certain polluted waters. Large algae growths may develop when nitrates and phosphates are made available through sewage decomposition. Hence, plankton may reflect changes in water quality resulting from changes in the composition of the wastes. So closely identified are the plankton types with the stream characteristics that it is frequently possible to identify the stream itself from the laboratory analysis of the plankton population.

Coliform Organisms: Disease producing microorganisms gain entrance to water through fecal pollution. Coliform organisms are universally present in feces in large numbers and can be detected with comparative ease. They are therefore useful as indicators of fecal pollution. Information regarding fecal pollution is essential to water quality control, and data on coliform content help to point out trends in the pollution of surface waters by domestic sewage.

Organic Chemicals: Organic contaminants, particularly the synthetic and petrochemicals such as detergents, agricultural pesticides and coal tar hydrocarbons, are increasing rapidly in our surface waters. Samples of these substances are adsorbed on activated carbon by passing about 5,000 gallons of the water sample through an activated carbon filter during one week in each month. The organic chemicals are then extracted from the carbon, separated into about 10 fractions, and specifically identified where possible. Recent developments in the field of gas chromatography show promise of providing a specific method of identifying many of the pesticides directly from water samples without first being extracted by carbon filters.

Trace Elements: Twice each year, two-month composite samples prepared from the weekly samples are subjected to analysis for dissolved trace elements. Examinations provide background data on those elements which might have physiological or toxicological significance.

Regular Chemical and Physical Measurements: The examinations, generally performed by the local participating laboratories, include ammonia nitrogen, chlorine demand, color, dissolved oxygen, biochemical and chemical oxygen demands, temperature, turbidity, and mineral constituents. All of these tests are essential to determining the quality of the water, and each one has a special significance in indicating stream conditions.

Additional Biological Measurements: Two additional biological measurements have been initiated with the cooperation of State fish and game agencies. At selected Network stations, periodic estimates of fish populations and a study of benthic organisms (small aquatic plants and animals living along stream bottoms) are being made. These two interrelated measurement series will provide still more exact information on amounts and characteristics of chemical pollutants. As with the plankton populations, changes in volume and types of pollutants in water result in corresponding characteristic changes in bottom flora and fauna, and in fish populations.

e. Uniformity of Reporting by Participating Laboratories. Every precaution is taken to assure a high degree of uniformity and reliability in the data reported by the participating Network local laboratories. Techniques of its personnel are carefully reviewed before the laboratory is accepted into the Network. A special laboratory manual designed for Network operation has been published and personnel of the participating laboratories are instructed to follow it. In addition, all of the local laboratories analyze reference samples provided by the Network staff from time to time to check their techniques and evaluate their results. Finally, two or three times each year the Water Quality Section runs a special three day review course in Cincinnati for participating laboratory personnel.

f. Correlation with River Flow Data. Because the water quality data are of maximum use only when associated with river flow data to obtain total quantities of pollutants or other quantitative measurements, there is included in the annual compilations flow data obtained from the U. S. Geological Survey, the Corps of Engineers, and other sources.

g. Data Handling and Publication. All rountine laboratory results are placed on punch cards for use in preparing listings for reports and for statistical analyses. Currently, programmed routines are being worked out for the use of the digital computer. Transfer of laboratory information from the punched card to magnetic tape for use with the computer permits greater flexibility and greater speed in analyzing the significance of many laboratory determinations.

Prepared listings of Network data are sent out quarterly to all participating agencies, unless the unusual nature of individual analyses makes it necessary to call this to the attention of the responsible agency immediately. In addition to the quarterly listings, an annual compilation (PHS Publication No. 663) entitled Annual Compilation of Data, National Water Quality Network is published for each water year. It is available for the water years 1957-58, 1958-59, 1959-60, 1960-61, 1961-62.

A special study of the plankton populations in selected streams was conducted between July, 1959 and June, 1960. Results are published in Plankton Population Dynamics (Supplement No. 2, PHS Publication No. 663) which states that many rivers exhibit a "personality" recognizable by the kinds of dominant biota each supports. Various types of pollutants cause changes in the characteristic plankton populations and the stream's "personality" varies accordingly. It is hoped to apply these findings directly to problems of water quality evaluation.

h. Data Utilization. The National Water Quality Network is not an end in itself, but was established to provide the information required in controlling the quality of the nation's waters. One of the principle tasks of the Network operation is the analysis of data to determine trends, cycles, unusual values, ecological correlations, and epidemiological conditions in an effort to better understand our national water resource. Data being analyzed may cover a single station, the main stem of a particular river, an entire river drainage basin, or the entire country.

Data available from some of the Network stations now covers a period of about five years, with other stations covering lesser periods. While this is still too short a period in which to establish significant long-term trends for the various classes of data being collected, several studies on portions of the data have been published. The most recent is a study of the significance of radioactivity in surface waters as an indicator of the patterns of fallout from the weapons testing program, the presence of uranium mining and milling industrial discharges, and the effects on nearby water courses of nuclear energy plants used for power production. This rather complete study is being published in the June 1963, issue of Radiological Health Data, a monthly issuance of the Division of Radiological Health, Public Health Service.

i. Data Storage and Retrieval. A comprehensive data storage and retrieval system called STORET has been developed and tested by the Basic Data Branch. This new system will greatly facilitate the handling of water quality and related data collected by the Basic Data Branch, Comprehensive Projects, and other units.

In the STORET system, data are stored on magnetic tape and can be retrieved and printed out in several ways. Standard location coding, and data input procedures are utilized so that the system can be applied throughout the Nation. Computer facilities of the Robert A. Taft Sanitary Engineering Center are utilized for the mechanical operation of the STORET system.

The stream coding work required for utilization of the STORET system is being actively carried on by several of the Comprehensive Projects throughout the country. It is expected that coding work and other preparatory steps will have progressed to a point where the STORET system can be placed in operation by the spring of 1964.

TECHNICAL ASSISTANCE ACTIVITIES

Under the provisions of the Federal Water Pollution Control Act, the Secretary is authorized to provide technical assistance concerning the control of water pollution to Federal, State and local interests. There are frequent requests for such assistance. For example, written correspondence requiring more than 3,000 technical replies per year is received and answered. Nearly the same number of telephone inquiries and personal visits to the Public Health Service's Washington headquarters, Sanitary Engineering Center, and regional program offices are made by persons wishing technical guidance and information on water pollution and its control.

By means of technical assistance afforded to Federal, State, local and other agencies concerned with pollution control the available technical knowledge has been brought to bear to solve actual problems. In many cases, requests for technical assistance can be met, and recommendations provided, on the basis of existing information. In other cases, specialized studies extending for periods up to five years have been required. These special studies and projects have added substantially to technical knowledge and capabilities for coping with specific water quality problems of regional or national scope.

Funds Appropriated

Funds appropriated for technical assistance activities under P.L. 660 have been as follows:

Appropriations for
Technical Services Activities 1/
FY 1957-1965

Fiscal Year	Amount	Fiscal Year	Amount
1957	$ 834,000	1961	$ 939,700
1958	980,000	1962	1,443,000
1959	1,067,000	1963	1,578,000
1960	885,700	1964	1,844,000
		1965 2/	3,504,000

1/ Includes funds for technical training program and for Arkansas-Red Basin Project in years 1958-1959.

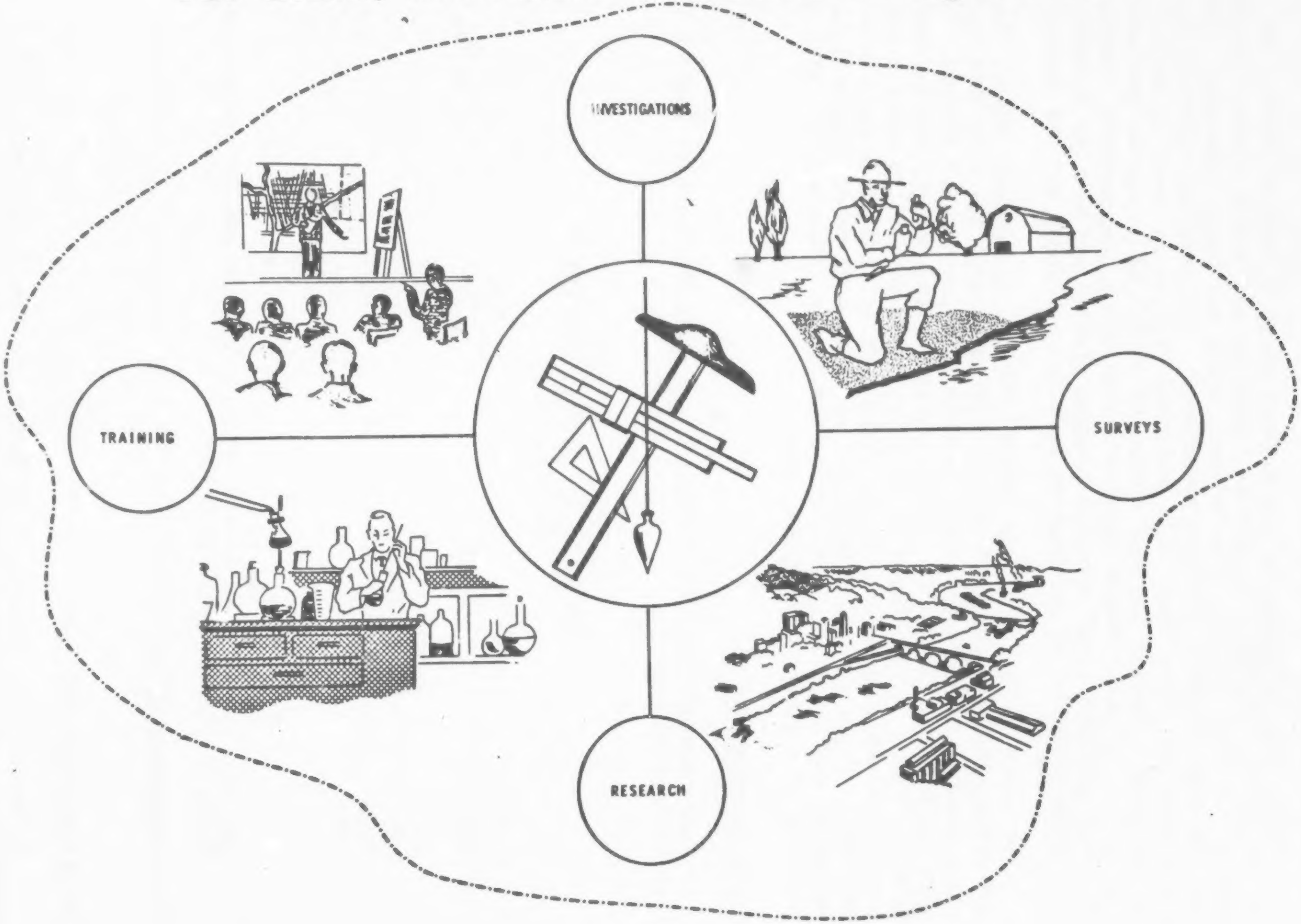
2/ President's Budget

Use of Appropriated Funds

In response to requests from Federal, State, interstate and local interests, major technical assistance and special investigations are carried out by experts from the Sanitary Engineering Center and/or by program

TECHNICAL ASSISTANCE

For State, Interstate and Federal Agencies


INVESTIGATIONS
TRAINING
SURVEYS
RESEARCH

ON UNUSUAL OR DIFFICULT PROBLEMS, AND WHERE NECESSARY SKILLS ARE NOT AVAILABLE personnel stationed in one of the nine HEW Regional Offices. These investigations include studies of water pollution causing severe damage to water uses, where the nature of the problem exceeds the existing technical capabilities of the State water pollution control authority.

Examples of assistance rendered during the past year are: to State of North Carolina in the confirmation of the suspected cause of a large fish kill on the Roanoke River; to State of Missouri in the development of recommendations for the improvement of pollution control by steel mills in the Kansas City area; and to State of California and the Bureau of Reclamation in dealing with aquatic nuisance problems stemming from irrigation development projects.

In many cases, the agency requesting technical assistance has been able to put the information received directly into effect, to achieve improvements in specific situations. For example, the information obtained from an evaluation of the water pollution effects of large soybean and mineral oil spillage in the Minnesota River was the basis for the development of a plan of corrective action. Moreover, this led to a revision of the State Water Pollution Control Act by the Minnesota Legislature, giving the State Water Pollution Control Commission broader powers and responsibilities. In another instance, at the request of the Federal Aviation Authority, a waste treatment system was designed by the Public Health Service for the Dulles International Airport. The treatment system was constructed and is working very satisfactorily.

At the request of Federal construction agencies or from the States that might be affected by the construction of water development projects, the Public Health Service provides technical evaluation in the areas of water supply, water pollution control and public health protection. The costs of the work done by Division personnel on such projects are sometime reimbursed to the Public Health Service by the Federal water construction agencies. Examples of this type of activity are: a pollution study in connection with the U.S. Corps of Engineers' Hilo Harbor Model Study in Hawaii; and a study to determine the effect of the new Hartwell Reservoir on pollution conditions in the Upper Savannah River. These special studies were added to the many other studies to determine the need for and the value of storage in Federal reservoirs for stream flow regulation for water quality control, which has already been described.

Technical assistance was provided to other Federal agencies in carrying out the work of the Interagency Committee on Water Resources, and to assist the International Boundary and Water Commission (United States-Mexico) in an evaluation of international pollution of the Tiajuana River. Assistance was provided to the State Department in its evaluation of the pollution of the lower Colorado River. The Division of Water Supply and Pollution Control also provides the technical staff to carry out the United States portion of the work on the pollution of boundary waters for the International Joint Commission (United States - Canada). Assistance was given to the Congress in the preparation of reports to the Senate Select Committee on National Water Resources. In addition, at the request of the Subcommittee on Natural Resources and Power, House Committee on Government Operations, statements were prepared on various facets of water pollution, such as acid mine drainage, radiological pollution and oil pollution in inland and coastal waterways. Also, a staff member of the Technical Services Branch, Division of Water Supply and Pollution Control, was made available to assist with the preparation of Subcommittee reports.

At the request of a large number of State water pollution control agencies, intensive field investigations were carried out to evaluate two new innovations in waste treatment in terms of their suitability for use across the Nation . These were the study of oxidation ponds and the evaluation of the extended aeration waste treatment process.

Recognizing the need for and desirability of drawing upon the knowledge and facilities of colleges and universities involved in water science activities, the Public Health Service has on occasion entered into cooperative agreements with these institutions. For example, there is a cooperative project with The Clemson Agricultural College to investigate the assimilative mechanisms in polluted waters. In addition, the Division has cooperated with the Johns Hopkins University, in developing a program of graduate studies in water sciences and management to provide broad graduate study opportunities for individuals working in special areas of the water field.

Special Projects

Two of the major technical assistance efforts currently underway deal with the realtionship between pesticides and water quality and recreation and water quality.

A field study of the effects of pesticide applications on water quality in the Southeastern United States has been in operation since 1959. This study was initiated in response to the vital need for information on the extent to which the rapidly-increasing use of such chemicals was affecting water quality and interferring with beneficial water uses. The objectives of this study are to determine the amounts and kinds of pesticides and herbicides entering surface and ground waters, the effects of these insecticides upon aquatic life, and the quantities remaining in waters treated for domestic use.

Findings to date confirm that pesticides used in the normal pursuits of man have fonnd their way into the aquatic environment, and subsequent efforts will be directed toward developing information concerning concentrations of pesticides throughout the fish food chain. The most effective analytical method currently available for the detection and measurement of pesticides, the gas chromatographic system, is being used in this project.

Recreation and water quality studies are underway in three different regions of the Nation-Indianapolis, Indiana (Geist Reservoir); Jackson, Mississippi (Pearl River); and San Diego, California (Santee water reclamation project). The purposes of these field studies are to determine the effects on water quality of the use of impounded waters for recreation and to determine the feasibility of using treated waste waters for recreation and fisheries.

The Santee Water Reclamation Project is pioneering in the field of waste water reclamation. This unique project involves the reclamation of water from sewage and subsequent reuse of the water for recreational purposes and irrigation. The objective of the study is to see whether sufficient reclamation can be accomplished through waste treatment to make these waters suitable for fishing, boating, and other water sports.

Other examples of special projects currently underway are the Klamath River Study, the Demonstration of Acid Mine Drainage Control and Abatement, and the Charleston Harbor-Cooper River Study.

The Klamath River flows from Oregon to the Pacific Ocean, crossing California, and includes in its basin a large wild fowl refuge, located on the Lost River,where fish kills, wildfowl kills, human dermatitis and other problems have occurred. The water pollution control study is directed toward abatement of pollution from excessive algea growths and pollution thought to result from intensive land use, where runoff waters carry significant quantities of minerals, pesticides and fertilizers leached from the soil.

In another area, a coordinated demonstration program dealing with acid mine drainage has been developed by the Department of Health, Education, and Welfare and the Department of Interior. More than 4,000 miles of major streams in the United States are polluted by acid from abandoned mines, refuse piles, and other sources, and abatement of acid pollution may be the key to development of depressed areas in the Appalachian region. The demonstrations of procedures and results of acid mine drainage control may involve such measures as mine sealing, diversion of inflow and acid drainage, and/or construction of equalizing reservoirs.

The U. S. Army Corps of Engineers has been investigating the Cooper River, South Carolina, with a view to reducing shoaling rates in Charleston Harbor. Possible remedial measures include plans to divert a portion of the Cooper River away from the Harbor, in order to prevent excessive silting. Since such measures would substantially modify the flow of fresh water into the harbor, their effects on the harbor pollution problem, water supply and other public health aspects require evaluation by the Public Health Service.

CONTROL OF POLLUTION FROM FEDERAL INSTALLATIONS

Inventory of Waste Water Disposal Practices at Federal Installations

The Federal Water Pollution Control Act authorizes a Federal program, in cooperation with State and interstate agencies and municipalities, for the control and abatement of water pollution emanating from Federal installations. Pursuant thereto, the President, in a memorandum dated May 13, 1960, requested the Secretary of Health, Education, and Welfare to prepare an inventory of waste water disposal practices at Federal installations as a first step in the discharge of this responsibility.

Because the General Services Administration, through its annual inventories of real property, had established effective working relationships with all Federal agencies, the Public Health Service requested the General Services Administration to cooperate in the task. A technical staff from the Public Health Service carried out the work, reviewed all incoming data, and arranged with the Bureau of the Census for preparation of the final machine tabulations and listings.

Inventory Coverage

The inventory covers waste water disposal practices of Federal activities on all real property owned by or leased to the Federal Government in all 50 States, the District of Columbia, the Commonwealth of Puerto Rico, and the Virgin Islands. Included also are the waste water disposal practices of wholly Government-owned corporations and non-Federal activities conducted on Federal properties, such as those of construction contractors and park concessionaires. The inventory included only those installations which were in existence as of December 31, 1960.

Not covered are trust properties; space leased to the United States for offices, including post offices, in non-Federally owned or operated buildings; land without activities generating wastes; lookout towers, ranger offices, and single living quarters in national forests and remote areas; and seldom-visited and/or unattended communications stations.

Reported Data

The inventory includes the following information reported by each installation: its name and geographic location; the type of activity which generates the wastes (i.e., whether Federal or non-Federal); the population served; the quantities of sewage and industrial wastes discharged per day; the percentages of each which receive treatment prior to discharge; the number of persons served by non water-carried waste facilities, if any; the quantities of solid industrial wastes generated; the type of operation or process which generates the industrial wastes; and, whether a formal notification has been received by an installation that a pollution problem is being created. The listing also indicates whether wastes are discharged into public utility sewer systems, into surface bodies of water, into the ground, or are transferred to other users for the irrigation of land.

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A summary of data included in the inventory is given in the Table on the following page. A total of 18,305 processed reports on sewage and industrial wastes from Federal installations is included. The table shows that 453.8 million gallons of sewage are discharged by the Federal installations each day, of which 201.3 million gallons receive no treatment prior to discharge. In addition, 10.2 billion gallons of industrial wastes are discharged per day. Of this amount 10.1 billion gallons per day are discharged without treatment, but 9.6 billion gallons of the latter are cooling water from power generators, air conditioning equipment, etc.

The reported data has beem compiled under three types of listings and printed by the Government Printing Office in 58 separate documents dated June 1962. The listings and volumes are as follows:

1. Volumes 1-53 cover reports for each of the 50 States, the District of Columbia, the Commonwealth of Puerto Rico, and the Virgin Islands. Listings are alphabetical by county and by city within each county. Where no city applies, the data are shown at the end of each county. No data on military installations appear in the volumes for Alaska, Hawaii, Puerto Rico, and the Virgin Islands.

2. Volumes 54-57 inclusive are agency listings covering, respectively:

   U.S. Department of Agriculture - Volume 54
   U.S. Department of Defense (classified confidential) - Volume 55
   U.S. Departments of Commerce, Interior, Justice, Post Office, State, Treasury, and Health, Education, and Welfare - Volume 56
   Independent agencies of the U.S. Government - Volume 57

These agency listings show the reports alphabetically by State and city within each State. Where no city applies, the data are shown by county at the end of the State.

3. Volume 58 contains Department of Defense (classified confidential) reports for Alaska, Hawaii, Puerto Rico, and the Virgin Islands. The listings in this volume are arranged in the same manner as in Volumes 1-53.

Current and Future Control Program

Based upon the findings of the inventory of waste water disposal practices at Federal installations, a program for the abatement and control of pollutional discharges from these installations has now been undertaken. This is primarily a field activity. The staffs of the regional program offices of the Division of Water Supply and Pollution Control work with the Federal installations in their regions to conduct surveys and investigations, provide technical advice and counsel in the solution of particular problems, assist in developing priorities for local action, and provide liaison between the Federal establishments and the State pollution control agencies concerned. In those cases where the field staff is unable to secure agree-

WASTE WATER DISPOSAL PRACTICES AT FEDERAL INSTALLATIONS
December 31, 1960
Summary of all Discharge Points

Discharge Point	TOTAL		SEWAGE				INDUSTRIAL WASTES					
			Total		Untreated		Total		Untreated		Cooling Water	
	No.	Gal/Day	No.	Gal/Day	No.	Gal/Day	No.	Gal/Day	No.	Gal/Day	No.	Gal/Day
Public Utility Sewers	8,136	178,295,809	8,131	155,845,220	8,119	155,158,681	189	22,450,589	156	17,321,235	104	7,063,671
Surface Water Body	2,058	10,415,601,778	1,718	250,786,290	744	45,167,633	554	10,164,815,488	452	10,015,501,938	221	9,593,122,945
Ground	7,585	76,683,597	7,493	45,733,769	674	990,978	198	31,149,828	160	22,299,951	60	16,366,874
Transferred to Other Uses	20	1,984,644	14	1,478,460	9	24,460	8	506,184	4	495,164	4	498,264
Total	17,799 1/	10,672,765,828	17,356	453,843,739	9,546	201,341,752	949	10,218,922,089	772	10,055,618,288	389	9,617,051,754
	4,857	386,790 2/	4,857	386,790 2/	4,769	379,148 2/						

1/ The number of reports for "Total sewage" and "Total industrial wastes" add to 18,305 because there were 506 reports which carried both sewage and industrial wastes. There were 443 reports that carried only industrial wastes.

2/ Persons using non water-carried waste disposal facilities.

ment on the programs to be followed, or cooperation in carrying these programs out, the problems are referred to Division headquarters in Washington.

By directive of the President, all Federal departments are being called upon to cooperate actively in this program as leaders in instituting optimum waste control practices, rather than merely acquiescing in local pollution control standards where these are minimal. All Federal installations located within areas where enforcement procedures under the Federal Water Pollution Control Act have been invoked and those which have been the subject of complaints are being included in immediate action programs.

A LOOK INTO THE FUTURE

THE WATER POLLUTION CONTROL ADVISORY BOARD

Competition for the use of limited water supplies will increase sharply in the years ahead. As increasing demands are made for the same bodies of water to provide for municipal and industrial supplies, fisheries, wildlife and recreation, irrigation, and other uses, many conflicts among the uses involved will arise. Pollution control programs will play a major role in determining how these competing demands can be met. Provision of the soundest possible technical appraisals and programs will go far towards resolving these water use conflicts, but many difficult policy decisions will have to be made. The objectives of water pollution control programs and the manner in which these are carried out will be guided by public desires and public needs.

The Water Pollution Control Advisory Board, with its broadly representative membership, can play a highly important role in keeping the Federal water pollution control program closely attuned to public needs. It is apparent that the Board's contribution to matters of Federal program policy and direction are going to be increasingly significant in the future. In addition, the Board can contribute greatly to future consideration of such matters as the relative responsibilities of the State and Federal governments for coping with various aspects of the overall pollution problem.

The Board has been able, over the years, to approach its responsibilities in an independent manner. This enables the Secretary to receive at times what might be referred to as "bold recommendations" and weigh them in the light of political and economic pressures which are important to temper final decisions.

In addition to interpreting and reflecting the views of the public to the Secretary, the Board, with the prestige of its membership, could do much to bring American people to an accurate awareness of the problem and issues of water pollution by continuing efforts which it is already making in this direction.

RESEARCH

Lack of information on many problems is impeding progress in water pollution control today. The ability of present water pollution research programs to provide the necessary answers has been far outstripped by rapid increases in technology, intensification of water use, and other factors. The rate of development of new industries and new products and the increasing re-use of water resources expected in the years ahead give every indication that the number of unknowns will continue to rise.

The inability of water pollution research to keep pace with the problem is due largely to a limited research budget, compounded by other factors. These include narrow and even vague definitions of research needs, in the light of the pace of industrial growth and technological development, ineffective communication among research scientists in spite of the increasing output of technical documents and frequency of conferences, inadequate planning to meet long-range personnel requirements, uncoordinated research by numerous small groups working independently, and delay in spanning the gap between research findings and improvement in water quality protection practice.

A greatly strengthened and more coordinated research program will be needed to develop the information which will enable us to restore and preserve the purity of the Nation's waters. Accomplishment of the research task would require extension and expansion of Federal support for water pollution research, both within the Public Health Service and at universities and other research organizations, undertaken through the provision of research grants. Appropriations support several times that of the present would be required to implement the necessary overall program. The research program will be carried out by making full use of the research capabilities of all competent individuals, agencies, and organizations whether engaged in public or private effort.

Research within the Public Health Service

National Water Quality Research Centers

A major future need will be the establishment of national water quality research centers, to guide and coordinate the overall national effort of research on water pollution control, and to undertake the basic research necessary to this program. These national centers would consist of the Water Quality Standards Research laboratories at Duluth, Minnesota and Kingston, Rhode Island, the present facilities at the Sanitary Engineering Center at Cincinnati, Ohio, and new facilities to be constructed in the future including a center for studies on waste water reuse.

The national research centers would guide the overall research program by identifying and defining research problems at an early stage. The need to anticipate research problems is evident. Both the detergent and the pesticide problems were on us before we came to grips with them in the research laboratory. Only after most of our major cities had felt the impact of pollution by sewer overflows did we begin to study the inherent pollutional character of storm water runoff from developed land areas. The effect of dispersed population groups in an urbanized area on the quality of the surface and ground water resource is not yet being studied in organized fashion. Other very important research problems may exist, unforeseen and unnoted. The national research centers would provide a means of recognizing and defining research problems before their impact is actually felt, and while there is still time to undertake the research which will enable effective preventive action. These centers would provide a means of promoting a coordinated attack on research progress and findings, producing inventories of research, publicizing timely information on special problems of research personnel, and taking all appropriate steps to assure the best possible use of the Nation's resources for research in water quality.

The national water quality research centers would be composed of national programs for water quality chemistry, for water quality microbiology, for aquatic life and wildlife, for engineering and engineering sciences, and for medical sciences. These platforms would provide the means of accomplishing.

the basic research necessary to support an effective national program for water quality control. The basic work done by these programs would point the way to more applied and developmental projects, which could then be carried out at the Public Health Service's regional water quality laboratories. The basic facts developed by the national programs would be adapted for actual use in solving pollution problems in various parts of the Nation, by the regional laboratories.

Each national program would be a focal point in the Nation for research in its area, and each would serve as a consulting and reference laboratory for public, industrial, and university groups engaged in water quality studies.

The National Program for Water Quality Chemistry would be equipped and staffed to separate, identify and measure any chemical impurity in water and waste, and to produce a sufficient quantity of this material to determine pollutional effects. It would develop practicable analytical methods for impurities of widespread concern. As part of this schedule, the program would conduct studies on chemical and physical chemical reactions in dilute solution as a basis for predicting the behavior of important pollutants and removal of pollutants. Analytical, physical, organic, inorganic, surface, bio-, biophysical and other chemists will be part of this agenda.

The National Program for Aquatic Microbiology would be equipped and staffed to conduct fundamental research on the nutritional requirements, living processes and ecology of bacteria, viruses, fungi, protozoa, algae and microscopic worms in the fresh water and marine environment. Its goals would be to interpret the significance of specific microorganisms in water, to develop improved methods for rapidly detecting, identifying and enumerating such significant microorganisms, to develop reliable methods for detecting disease-producing microorganisms, and to develop methods for destroying or otherwise controlling microorganisms. The program would conduct research to better understand microbial metabolism so that improved methods of biological treatment may be developed. Studies involving microbial genetics, molecular biology, enzyme chemistry, and membrane technology will be undertaken. Controlled bio-treatment, in an attempt to produce useful by-products from wastes treatment, will be investigated.

The National Water Quality Program for Aquatic Life and Wildlife would be equipped and staffed to conduct research on the water quality requirements for protection of aquatic and wildlife. It would conduct basic studies on environmental, nutritional, ecologic and physiologic conditions affecting the health, wholesomeness, and behavior of important aquatic forms. Acute and chronic tests to determine the critical stage in the life cycle, or in the organism-food chain will be developed. The mechanism of toxicity will be studied. Based on these studies, the program would recommend appropriate water quality criteria. As part of this research, methods would be developed to utilize aquatic life most effectively as sensitive indicators of water quality conditions. Research would be directed to the relationship of pollutional factors to the productivity of important aquatic life. Initially, these functions will be carried on at Cincinnati and at the Water Quality Standards Research Laboratories at Duluth and Kingston. The national program will eventually require a new fresh water laboratory in southern U. S., a new marine laboratory on the Gulf, and an expanded West Coast marine facility at Corvallis, Oregon.

The National Water Quality Program for Engineering and Engineering Sciences will be equipped and staffed to develop devices, establish design criteria, and set forth procedures for protecting water quality in streams, lakes and impoundments, ground water and in coastal areas. Special laboratory programs would be developed for its major operations: (1) Laboratory schedules would be established to conduct the laboratory, pilot plant and demonstration projects of the Advanced Waste Treatment Research Program. Appropriate steps would be taken, through their research and development program, to assure that industry's full potential would be applied to this national endeavor. (2) A laboratory agenda would be established to initiate and conduct a national program for controlling nutrient enrichment of stored waters to prevent the growth of nuisance aquatic plants. (3) A special laboratory program would be established to study the effects of pollution on ground water quality. As part of this study, procedures would be developed for the optimum use of the soil mantle and deep soil formations in waste disposal. (4) A laboratory program would be established to develop efficient procedures for use of stored waters for quality control, for stream flow management, and for stream quality surveillance. Since the geographical factor is important in many of these studies, this research will be conducted cooperatively with the Regional Laboratories. (5) A program to define and control the pollution from land drainage including urban and rural runoff will be developed. (6) Socio-economic research as related to water pollution and its control will be carried out. (7) Operations Research and Systems Analysis techniques will be developed and applied to water pollution control. (8) Staff will consist of engineers with various specialization including sanitary and chemical engineering scientists, and researchers in the socio-economic areas. Computer, both analog and digital, techniques will be developed.

The National Water Quality Program for Medical Sciences would be equipped and staffed to conduct research on the effect of pollutants on public health. A toxicological group would be established to conduct research on physiology, biochemistry and pharmacology as a basic step in developing screening procedures for estimating a pollutant's toxic or carcinogenic potential for humans. Special emphasis would be placed on development of methods for determining, in a short time, a pollutant's harmful potential following long-term exposures. The toxicological group would work closely with other highly competent research groups supported with contract and grant funds. Current epidemiological studies would be expanded to determine the relationship of public health to quality of public water supplies. The program would undertake studies on the relationship of public health to the quality of recreational waters.

Regional Research Laboratories

Supplementing the basic research program of the proposed national water quality research centers and its five functional programs, the seven regional research laboratories currently authorized and being planned, will conduct research of a more applied or developmental nature. The research will relate to specific regional problems, in many cases involving field studies of actual situations. Each of these regional laboratories will be staffed, equipped and programmed for study of pollution problems which result from the particular climate, geography, and special water use and water characteristics of the region involved.

Subject to national guidance and coordination which would be provided by the national water quality research centers, each regional laboratory will guide and coordinate the overall research efforts within its region. The staff of the laboratory will identify the specific problems requiring attention, in cooperation with the administrators of State and Federation pollution control programs, university research personnel, representatives of industries, and others concerned within the region. After these research needs have been identified--and this is a continuing process--the overall research task will be accomplished in a number of ways.

Many of the necessary research projects will be undertaken directly by the regional laboratories. For others, contractual arrangements with universities or other research institutions will be made, to draw upon the special talents and competence which is available within the region.

The laboratory will also bring the water quality research needs of the region to the attention of other scientists in the region, through meetings, seminars and other means. Through directing attention to the most significant water quality problems and providing guidance to applicants for public health service research grants, the regional laboratory will tend to reduce fragmentation of the regional research effort into small, unrelated and uncoordinated research projects.

Although the 1961 Amendments to the Federal Water Pollution Control Act specify seven regions of the Nation for which laboratories shall be constructed, the Act does not limit the total number of laboratories which could be authorized to these seven. Already, it is apparent that laboratories will be required to cope with the research problems of several additional regions.

The regional laboratory for the Midwest area, which has been tentatively determined to embrace all or parts of twenty-five states, will be located at Ann Arbor, Michigan. This great central region of the Nation contains the major river basins of the Ohio, Upper Mississippi, and Missouri rivers and the Great Lakes, or approximately one-third of the land mass of the continental United States. In order to afford equal priority and concurrent attacks upon the problems of the Mississippi and Missouri basins, an additional laboratory is required to serve these two largest watersheds in the Nation. Amply demonstrated needs and many earlier studies suggest that the proposed facility be located in the Missouri Basin.

The Great Lakes comprise the largest body of fresh-water supplies available to the Nation. The magnitude and urgency of pollution problems in the Great Lakes indicate that a large scale research effort for this region should have high priority. This need was recognized by the 1961 Amendments to the Federal Water Pollution Control Act which requires that "The Secretary shall conduct research and technical development work, and make studies, with respect to the quality of the waters of the Great Lakes, including an analysis of the present and projected future water quality of the Great Lakes under varying conditions of waste treatment and disposal, an evaluation of the water quality needs of those to be served by such waters, an evaluation of municipal, industrial, and vessel waste treatment and disposal practices with respect to such waters, and a study of alternate means of solving water pollution problems (including additional waste treatment measures) with respect to such waters." Under present arrangements, such studies would be

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undertaken at the Ann Arbor laboratory. However, in order to meet this research need, which is of a special nature and magnitude, a separate Great Lakes laboratory should be established.

The basic water scarcity of the Pacific Southwest as contrasted with its soaring water needs, makes it apparent that this is a third region where an additional laboratory will be required. Most portions of this area are more than a thousand miles from either the Pacific Northwest Laboratory in Corvallis, Oregon, or the Southwest Laboratory at Ada, Oklahoma. The Great Basin States of Nevada, Western Utah, and California, as well as the adjacent Colorado Basin States of Colorado, Arizona, and Eastern Utah, would benefit from a Pacific Southwest Laboratory.

Research Information Service

The need for better communication among scientists and engineers working in the water supply and pollution control field has long been recognized. Available information is widely scattered and largely inaccessible to workers in this field except through arduous and time-consuming searching. In addition, as more and more professions such as oceanography, soil science, and economics become involved in the increasingly complex and far-reaching problems of water quality control, the problem of assuring adequate information exchange becomes even more difficult. In order to effectively utilize the available research potential in the water field, the basic tool of extant knowledge must be made available to scientists and engineers in an expeditious and complete manner. They will thereby be able to avoid duplication, take advantage of existing knowledge, and devote more of their time to productive research work.

Research information services in the Division of Water Supply and Pollution Control should be expanded to meet these needs. These services should (1) develop a complete collection of research documents in the broad field of water supply and pollution control; (2) establish a storage and retrieval system to furnish rapid access to that literature; and (3) furnish information to serve the needs of research scientists and engineers in the water field.

Plans have been developed for the expansion of research information services. During the 1962-1970 period, a major effort will be made to bring the research document collection up-to-date and to make it as complete as possible. This effort will include services for translation of important foreign language documents, and cooperative exchange programs with other countries throughout the world.

This period will also see development of the basic reference service to scientists and engineers into a comprehensive system designed to fulfill a wide variety of information needs of research workers. Included will be such programs as: (a) current awareness services to individual scientists and engineers to help them maintain currency with their specific areas of research interest; (b) selective publication services indicating bibliographic information and eventually containing monographs summarizing existing knowledge in specific areas of research effort; and (c) dissemination to major research centers in this country and abroad of the document collection and potentially the index and retrieval system for the collection. The basic program plan for information services is based on the sound development of a comprehensive, national center for research documentation in the field of water supply and pollution control.

Extra-Mural Research

Although, as indicated above, the Public Health Service's internal program for conducting research should be greatly strengthened, the future water quality problem will be of such magnitude that no one agency can be expected to accomplish the entire task. We will have to continue to look to research conducted outside the Public Health Service to provide many of the needed answers. Since a large proportion of this work is stimulated and supported by research and demonstration grants, these two ongoing programs will require substantial expansion.

In the research and demonstration grant programs, the task of future development is a large one. Currently, these programs exhibit backlogs of approved but unpaid grants. Therefore, the first objective in each program is to bring available support into line with demonstrated need. Funds are required to continue ongoing projects and programs, and to award all new approved grants; and to fund the backlog in each program.

In 1962, the Committee on Environmental Health Problems (Gross Committee) recommended levels of support in each grant program to be reached by 1970. The average annual increase in funds over the 1962-1970 period recommended by the Gross Committee was about 31%. The following table indicates the FY 1963 appropriation levels and the FY 1970 recommendations of the Gross Committee:

Research and Demonstration Grants Program Growth

1963-1970

	1963	1970
Research Grants	$3,285,000	$20,000,000
Demonstration Grants	500,000	6,000,000
Total Research	$3,785,000	$26,000,000

For research grants, the proposed increase from 1962 to 1970 represents an annual increase in funds of about 27.5%. The effective increase in numbers of projects is estimated to be only about 20% per year over the 8-year period. Thus, the number of research projects to be supported would rise from 159 in 1962 to about 800 by 1970. It is expected that this increase will allow the research grants program to gain and maintain currency with approved applications, and to expand into gap problem areas as these occur over the 1962-1970 period.

For the demonstration grant program, the proposed increase represents an average annual increase in funds of 45%. Such rapid expansion is required in this program because of the substantial backlog of research information which has not yet been investigated for its practical application. Demonstration grants are expected to increase substantially in size over the 1962-1970 period with an estimated maximum annual growth in numbers of projects of 40%. This would result in an expansion from 11 grants in 1962 to about 160 in 1970. The expansion described above is felt to be a minimum requirement if significant advances in the practice of water and waste treatment are to be made and widely utilized.

Major objectives in future development of the research grant program include: (a) expansion of the program to schools not currently active in the water supply and pollution control field; (b) expansion of the number of disciplines being utilized in the attack on water pollution; (c) development of multidisciplinary programs which simultaneously utilize a variety of disciplinary approaches in the solution of a specific problem; and (d) expansion of the research grant program to investigations of critical problem areas not currently receiving adequate attention.

The demonstration grant program, to be an effective follow-up to research activities, must grow concurrently with the research grant program. Objectives in the demonstration grant program include: (a) rapid development of resources (manpower and facilities) capable of applying new research knowledge to practical end uses; (b) particular development of the potential of State and local official agencies to carry on this kind of work in conjunction with their control and enforcement activities; (c) increasing emphasis on the dissemination of results of demonstration grant programs to the greatest number of potential users of that information.

TRAINING

Closely related to the need for expanded research programs is the problem of training. The growing shortage of skilled personnel in all fields of engineering and science, together with the increasing diversity and complexity of water supply and pollution control problems, makes advanced training a matter of high priority. There is an urgent need both to train research scientists and engineers who can develop improved technology for coping with water supply and pollution control problems, and to improve the training of the practicing engineers and scientists in the field in order that they can utilize the flow of information resulting from research and technological improvements.

The Public Health Service's long-range objectives to meet these problems and needs are:

1. To provide personnel of local, State and interstate agencies, industry and other Federal agencies with an opportunity to learn and put into practice the latest research and technical developments in water supply and pollution control. This will provide for both the improvement in skills of practicing engineers and scientists, and an accelerated translation of new technological developments into actual practice in the field.

2. To provide appropriate training courses for municipal, institutional and industrial water and waste treatment works operators to improve their competency in plant operation and maintenance, and to keep them continuously abreast of the latest techniques.

3. To upgrade the technical skills and broaden the scientific background of career personnel of the Division of Water Supply and Pollution Control through advanced training programs. Advanced training of personnel will enable the Division to increase its technical and scientific capability, develop its own specialists in shortage categories, and better cope with the difficult problems of water pollution in which it has responsibilities.

4. To provide for career development and opportunity for personnel of the Division of Water Supply and Pollution Control to keep abreast of recent advances in their fields of specialization. In addition to improving skills, this will provide an inducement for Division staff to remain in water supply and pollution control for their careers.

5. To increase numbers of scientists and engineers working in this field, through establishment and expansion of graduate training programs at educational institutions and through support of graduate research training for individual specialists. Although some of the personnel trained as a result may be employed by the Public Health Service, the basic purpose is to increase the overall supply of persons trained to work on water pollution control.

Accomplishment of these objectives will require strengthening and expansion of existing programs as follows:

1. The Public Health Service's training activities related to water supply and pollution control should be greatly expanded. It is estimated that, to keep pace with demands, the appropriations necessary to support this activity would have to increase over five-fold during the five year period from fiscal year 1964 through fiscal year 1968. This would provide for increases in the following activities:

a. Short-term, intensive lecture and laboratory technical training courses at the Sanitary Engineering Center and the regional laboratories for Division staff and personnel from other Federal, State, interstate and local agencies and from industry. The capabilities of the Public Health Service staff to provide these special courses designed to train practicing personnel in the latest research and technical developments would be increased. During the initial stages, this would involve training the persons who will be responsible for training programs at the regional laboratories at the Sanitary Engineering Center.

b. Sponsorship of seminars and conferences on special subjects of interest at the Sanitary Engineering Center and regional laboratories designed to focus the attention of specialists on specific problems, progress and needs.

c. Short-term, practical training courses for operators of municipal, institutional and industrial waste treatment works, designed to improve their capabilities, and stimulate their interest in efficient treatment plant operation and maintenance. A great deal of pollution can be removed from the Nation's streams through improved treatment plant operation. Further, the plant operator needs to know that he has an important role along with the engineer and scientist.

2. Long-term, outside-the-service postgraduate training at selected universities for career development of Division personnel who have a satisfactory academic background, outstanding work performance, and an

expressed interest in a career in the Service should be increased. Such long-term graduate training in selected universities will provide for the development of highly specialized skills, including those in shortage categories difficult to recruit.

It is estimated that the numbers of personnel of the Public Health Service's Division of Water Supply and Pollution Control receiving graduate training should be increased from seven during FY 1963 to 65 during FY 1968. This will enable the Division to increase the skills of its professional staff in an increasingly wide range of disciplines, such as water resources engineering, oceanography, hydrology, physical chemistry, mathematics and economics.

Short-term, out-the-service training in university and other teaching institutions should be expanded at a commensurate rate to allow Division personnel to keep abreast of developments in their specialty, or to broaden the scope of their technical capability.

3. The Public Health Service's training grant and research fellowship programs should be expanded in order to help increase the supply of qualified manpower in all phases of water supply and pollution control activity. It should be noted here that increased funds alone will not solve the manpower problem. There currently are limitations on the numbers of institutions and individuals who are interested in and capable of contributing to the effort of training personnel for careers in water supply and pollution control. Emphasis here must include the development of interest and capabilities so that available funds may be effectively expended.

In the development of the training grants program, objectives should include: (a) the development of training potential in a larger number of institutions than are available currently; (b) particular emphasis in fields which relate to water supply and pollution control, such as chemistry, microbiology and economics; (c) development of interdepartmental curricula which better prepare students to make significant contributions when they complete their training; and (d) the broadening of support to institutions to include special training programs and to support basic undergraduate education relating to water supply and pollution control.

Objectives of the research fellowship program include: (a) maximum expansion of the program within the requirement of demonstrated research potential by the individual applicant; (b) support of the greatest variety of disciplines which relate to water supply and pollution control; and (c) broadening of support for special postgraduate study, particularly for those individuals who currently hold teaching and research positions at academic institutions.

The Committee on Environmental Health Problems(Gross Committee) in 1962 recommended levels of support for the training grants and research fellowships programs to be reached by 1970. The recommended levels as compared with current levels are as follows:

Training Grant and Research Fellowship Program Growth

	1963	1970
Training Grants	$1,100,000	$4,000,000
Research Fellowships	300,000	1,000,000
Total Training	$1,400,000	$5,000,000

As in the case of research and demonstration grants, there are backlogs of approved but unpaid grants; and funds are required to continue ongoing grants and fellowships; to award all new approved grants; and to fund the backlog in each program.

The Committee's recommendation represented an average annual growth rate from 1962 to 1970 of about 26 percent. Accomplishment of the recommended growth rate would result in an increase in students supported from 171 in 1963 to about 700 in 1970. The total number of students completing training during the 1962-1970 period would be about 1,500. This falls far short of the estimated need for personnel cited in the Gross Committee Report. That report pointed to needs during the same period for 4,000 new engineers and about 10,000 allied scientists in the entire water supply and pollution control field. Clearly all of the training in this field cannot, and should not, be supported by the Federal government. However, the estimated training output of 1,500 represents only slightly more than 10 percent of the requirement. Only the increased stimulation and development of programs in institutions now inactive in the water field will correct this problem.

The training grant program would, under the Gross Committee recommendations increase at a rate of about 24 percent per year. As the training grant program develops, it is expected that the cost per project will increase substantially, largely because of support for growing numbers of students under these grants. If a 20 percent annual growth rate in numbers of projects holds, then expansion of training grants would be from 35 grants in 1963 to slightly more than 100 in 1970.

As noted earlier, this program projection comes nowhere near to fulfilling estimated needs, but is based primarily on a conservative evaluation of potential. It should be emphasized that as more institutions develop interest and capabilities in the water field, funds should be made available to them to establish training programs and become a part of this critical national resource.

The Gross Committee recommended that research fellowships be increased from $100,000 in 1962 to $1,000,000 in 1970. Here the limitations on available resources are very real. This program should be limited to support of highly qualified persons with demonstrated ability to perform independent research at an advanced level. The recommended increase would expand support from 45 fellows in 1963 to about 125 in 1970. It is expected that during this period the cost per fellowship will increase as more awards are made for post-doctoral and special fellowships.

4. The regional laboratories should, in the course of their research activities, assist in training and attracting graduate students to careers in water pollution control. The legislation authorizing the establishment of these laboratories states that "Insofar as practicable, each such facility shall be located near institutions of higher learning in which graduate training in such research might be carried out." Close working arrangements should be developed with the universities at which the regional laboratories are located. Cooperative research projects should be developed which would make the excellent equipment and facilities of the laboratories available to faculty scientists and graduate students, and government scientists might be used to strengthen university teaching staff in certain specialized areas. Such measures would do much to attract competent individuals into the field of water quality control.

INFORMATION

With increasing pressures and competition for use of the Nation's water resources, the public will find itself having to express its views with respect to how its water resources should be developed and used more and more often. This clearly points to the need for a strong public information program. This need was highlighted by the President's Water Pollution Control Advisory Board in February 1963, when it reviewed the current activities of the Division of Water Supply and Pollution Control's information program and passed the following resolution:

> Because the support of public opinion is so necessary to the abatement of water pollution in the United States, the Board has repeatedly urged upon the Public Health Service that it undertake active programs of public information showing the public the dangers of pollution to the health and welfare and emphasizing the need for active programs of water pollution control. Such an activity is now being undertaken by the Public Health Service in response to these wishes of the Board and this activity appears to be successful and useful.
>
> The Board recommends that this program be continued and strengthened and further recommends to the Public Health Service that it encourage similar programs among the State and interstate agencies. Such programs, carried on cooperatively by Federal, State and local governments, can do much to alert the public to the need for water pollution control and will increase public support for the local and State agencies concerned.

This resolution points to one of the major needs facing the information program in the next several years, that of encouraging expanded information activity on the part of the State and regional pollution control agencies.

It is a vicious circle that many State pollution control programs lack adequate support because the public does not know of them or what they do. One of the reasons the public does not know is because the State agencies have never had enough support to do an adequate job of public awareness and information. By the same token, it is apparent that some local sewage bond issues have failed to pass because their sponsors did not establish adequate promotional campaigns. (Among the many exceptions worthy of note was the outstandingly successful campaign which preceded the $95 million St. Louis bond election in November 1962. A truly outstanding local campaign, professionally directed, was instrumental in obtaining public approval by more than 5-to-1.) The present capabilities of the Division of Water Supply and Pollution Control's Information Branch to provide support and guidance to State and local agencies in developing public awareness, should be expanded.

In addition to the need for strengthened public information services, there will be a continuing need to improve the flow of information among professional workers in water pollution control--both the scientists and the personnel carrying out pollution control programs in the field. This need for better technical communication should receive increased attention in all aspects of the Public Health Service's program. The important part which improvement of the flow of information should play in the Public Health Service's research and training activities has already been described.

With the development of new scientific and technical information as a result of research programs, comprehensive planning projects, and other activities, there will be a particular need for more efficient means of producing and disseminating technical reports. This will call for greatly increased technical editing and report production services.

GRANTS FOR STATE WATER POLLUTION CONTROL PROGRAMS

Existing deficiencies in State water pollution control programs, and the role which Federal grants have played in upgrading these State programs has already been described. Expanded authorization and increased appropriations for State program grants under Section 5 of the Federal Water Pollution Control Act would provide further means of strengthening State programs.

The State aid program should also be re-examined from the point of view of possible changes in the formula for distributing funds, and for a tightening of Federal legislation to require that money be spent for specified water pollution control activities within the State.

GRANTS FOR CONSTRUCTION OF MUNICIPAL WASTE TREATMENT WORKS

(a) Backlog of needed waste treatment works.

An annual Survey of municipal waste treatment needs is conducted by the Conference of State Sanitary Engineers in cooperation with the Public Health Service. The 1963 Survey disclosed that there are 1,550 municipalities discharging untreated sewage which requires new plants for the treatment of wastes from a population of 13,051,000. An additional 1,535 cities and towns with existing treatment plants require new or enlarged facilities because of obsolescence, insufficient treatment or capacity. These communities presently discharge into the Nation's streams inadequately treated wastes from a population of 17,009,000.

While unsewered communities are not usually important sources of water pollution, they frequently experience serious ground water pollution and other public health problems arising from the individual disposal of sewage. There are 2,746 unsewered communities reported by State Health Authorities which require sewer systems and sewage treatment plants for a population of 5,807,000.

The estimated cost of this present backlog of 5,831 needed projects is $1.2 billion for treatment plants and $1.0 billion for interceptor and outfall sewers and other ancillary works, or a total of $2.2 billion.

A detailed breakdown of the backlog of needed waste treatment works is shown on Tables I-IV on the following pages.

(b) Additional needs because of population growth and obselescence of existing facilities.

The population served by sewer systems in the United States increased from 98.4 million in 1956 to 118.4 million in 1962. This was a 20 percent increase in six years. During this same period, the total urban population of the country increased about 15 percent. Thus, the growth rate of sewered population was somewhat greater than that of total urban population, indicating that installation of sewers is beginning to catch up with the population. Accordingly, it would appear that eventually, growth of the sewered population should closely approximate that of the urban population.

Municipal waste treatment needs for the expanding urban population have been estimated by extrapolating the present sewered population of 118 million through 1980, using the 1950-1960 urban population growth rate of about 30 percent. Present and estimated future populations served by sewer systems are as follows:

1956	98.4 million	(actual)
1960	117.8 million	"
1965	132 million	Estimated
1970	152 million	"
1975	174 million	"
1980	200 million	"

BACKLOG MUNICIPAL WASTE TREATMENT NEEDS

January 1, 1963

I. COMMUNITIES DISCHARGING UNTREATED SEWAGE

	1963		
	Number	Population Served	Cost in * Thousands
Population Size Group			
Under 500	233	69,693	$ 11,647
500 - 1,000	284	206,394	22,766
1,000 - 5,000	742	1,595,073	127,127
5,000 - 10,000	151	1,028,555	59,635
10,000 - 25,000	85	1,299,853	58,111
25,000 - 50,000	25	914,556	31,441
50,000 - 100,000	20	1,896,063	41,154
Over 100,000	10	6,041,357	89,144
States			
Alabama	39	154,800	6,783
Alaska	18	79,059	4,886
Arizona	3	31,686	1,832
Arkansas	12	83,131	3,827
California	10	12,080	1,069
Colorado	30	23,574	1,869
Connecticut	17	64,740	5,609
Delaware	0	0	0
District of Columbia	0	0	0
Florida	18	104,600	4,164
Georgia	47	279,542	13,410
Guam	2	4,749	294
Hawaii	2	28,600	1,393
Idaho	34	40,894	3,223
Illinois	29	223,416	9,878
Indiana	41	87,244	8,725
Iowa	56	136,730	10,640
Kansas	4	135,930	2,990
Kentucky	45	89,237	7,795
Louisiana	16	766,736	14,831

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*Cost of plant excluding ancillary works.

Communities Discharging Untreated Sewage
Page 2

	1963		
	Number	Population Served	Cost in* Thousands
States			
Maine	41	318,554	$ 18,298
Maryland	11	36,091	2,144
Massachusetts	33	448,650	14,493
Michigan	No Report		
Minnesota	50	44,800	6,120
Mississippi	36	120,503	2,891
Missouri	36	4,584,850	63,107
Montana	3	4,500	125
Nebraska	65	133,487	9,152
Nevada	2	4,483	204
New Hampshire	66	210,300	13,871
New Jersey	0	0	0
New Mexico	1	1,000	114
New York	136	901,450	39,059
North Carolina	61	563,544	21,991
North Dakota	15	56,612	857
Ohio	8	20,138	1,363
Oklahoma	7	7,517	310
Oregon	15	34,150	3,428
Pennsylvania	254	1,224,122	64,928
Puerto Rico	2	6,615	606
Rhode Island	1	1,240	104
South Carolina	28	354,407	8,561
South Dakota	20	25,440	992
Tennessee	18	627,390	13,527
Texas	3	29,849	1,283
Utah	38	51,687	3,979
Vermont	14	40,859	2,423
Virginia	54	67,436	6,407
Virgin Islands	3	15,650	1,644
Washington	34	551,235	17,457
West Virginia	65	212,200	17,753
Wisconsin	5	2,690	415
Wyoming	2	3,347	201
U.S. TOTALS	1,550	13,051,544	$441,025

*Cost of plant excluding ancillary works.

BACKLOG MUNICIPAL WASTE TREATMENT NEEDS

January 1, 1963

II. COMMUNITIES DISCHARGING INADEQUATELY TREATED SEWAGE

	1963		
	Number	Population Served	Cost in* Thousands
Population Size Group			
Under 500	184	58,026	$ 6,797
500 - 1,000	279	198,692	16,819
1,000 - 5,000	712	1,587,480	95,468
5,000 - 10,000	156	1,057,033	47,144
10,000 - 25,000	122	2,784,737	79,793
25,000 - 50,000	31	1,190,521	28,464
50,000 - 100,000	21	1,336,026	40,381
Over 100,000	30	8,796,424	102,255
States			
Alabama	28	177,750	6,642
Alaska	0	0	0
Arizona	13	77,483	3,286
Arkansas	41	124,269	6,260
California	63	1,676,601	46,296
Colorado	47	823,590	17,656
Connecticut	19	564,440	14,176
Delaware	0	0	0
District of Columbia	0	0	0
Florida	24	849,360	11,818
Georgia	34	187,081	5,732
Guam	0	0	0
Hawaii	1	1,000	401
Idaho	20	27,323	1,051
Illinois	75	552,279	19,855
Indiana	23	580,129	10,375
Iowa	88	688,429	27,433
Kansas	41	250,153	6,317
Kentucky	25	95,421	5,245
Louisiana	23	201,231	5,574

*Cost of plant excluding ancillary works.

Communities Discharging Inadequately Treated Sewage
Page 2

	1963		
	Number	Population Served	Cost in* Thousands
States			
Maine	5	22,500	912
Maryland	4	5,521	845
Massachusetts	7	204,630	3,101
Michigan		No Report	
Minnesota	75	1,547,900	38,034
Mississippi	42	88,313	3,520
Missouri	32	373,757	7,255
Montana	23	101,650	2,787
Nebraska	28	164,125	3,218
Nevada	5	9,500	695
New Hampshire	6	27,100	1,303
New Jersey	16	172,172	7,445
New Mexico	13	64,706	2,305
New York	47	426,573	7,546
North Carolina	105	394,452	22,417
North Dakota	32	29,044	618
Ohio	32	522,889	9,732
Oklahoma	86	826,484	10,349
Oregon	34	165,220	15,531
Pennsylvania	9	52,789	3,127
Puerto Rico	5	45,160	1,355
Rhode Island	8	532,410	6,841
South Carolina	31	648,703	12,542
South Dakota	34	119,905	2,266
Tennessee	16	200,090	6,883
Texas	174	2,194,050	27,178
Utah	7	19,440	1,031
Vermont	0	0	0
Virginia	10	228,784	3,528
Virgin Islands	0	0	0
Washington	27	316,776	6,333
West Virginia	8	51,400	2,017
Wisconsin	47	559,805	17,882
Wyoming	2	16,552	408
U.S. TOTALS	1,535	17,008,939	$417,121

*Cost of plant excluding ancillary works.

BACKLOG MUNICIPAL WASTE TREATMENT NEEDS

January 1, 1963

III. UNSEWERED COMMUNITIES REQUIRING SEWAGE COLLECTION SYSTEMS AND TREATMENT FACILITIES

	1963		
	Number	Population Served	Cost in* Thousands
Population Size Group			
Under 500	924	272,636	$ 25,043
500 - 1,000	779	530,179	46,369
1,000 - 5,000	841	1,563,165	131,924
5,000 - 10,000	128	880,969	57,638
10,000 - 25,000	56	754,242	39,261
25,000 - 50,000	6	190,627	7,993
50,000 - 100,000	8	575,027	19,931
Over 100,000	4	1,040,030	19,760
States			
Alabama	25	34,650	2,649
Alaska	11	11,414	1,355
Arizona	13	24,304	468
Arkansas	41	29,979	3,042
California	196	336,604	38,303
Colorado	0	0	0
Connecticut	11	39,800	4,951
Delaware	3	3,309	284
District of Columbia	0	0	0
Florida	127	350,356	20,236

*Cost of plant excluding ancillary works.

III. Unsewered Communities Requiring
Sewage Collection Systems & Treatment Facilities
Page 2

Reproduced from best available copy.

States	1963		
	Number	Population Served	Cost in* Thousands
Georgia	31	45,691	$ 2,271
Guam	17	63,502	3,607
Hawaii	6	19,200	3,033
Idaho	52	37,331	1,733
Illinois	133	154,429	17,730
Indiana	5	8,674	928
Iowa	1	950	107
Kansas	55	30,065	1,242
Kentucky	13	16,943	1,787
Louisiana	100	213,182	13,960
Maine	14	23,314	2,377
Maryland	14	24,370	2,100
Massachusetts	20	105,671	6,288
Michigan		No Report	
Minnesota	58	81,800	11,788
Mississippi	95	57,101	917
Missouri	401	215,256	7,372
Montana	25	12,680	309
Nebraska	0	0	0
Nevada	2	88,000	4,317
New Hampshire	0	0	0
New Jersey	66	372,044	26,619
New Mexico	29	20,195	1,605
New York	661	2,400,220	105,818
North Carolina	13	28,940	1,987

*Cost of plant excluding ancillary works.

III. Unsewered Communities Requiring
Sewage Collection Systems & Treatment Facilities
Page 3

	1963		
	Number	Population Served	Cost in* Thousands
States			
North Dakota	3	1,595	$ 40
Ohio	39	104,403	9,823
Oklahoma	67	32,182	762
Oregon	51	135,040	8,265
Pennsylvania	135	364,042	18,695
Puerto Rico	1	800	114
Rhode Island	7	69,700	2,666
South Carolina	10	49,822	2,177
South Dakota	89	78,190	3,426
Tennessee	5	6,959	631
Texas	2	2,435	257
Utah	0	0	0
Vermont	0	0	0
Virginia	0	0	0
Virgin Islands	1	700	136
Washington	15	15,714	1,195
West Virginia	35	51,800	6,257
Wisconsin	48	43,519	4,292
Wyoming	0	0	0
U. S. TOTALS	2,746	5,806,875	$347,919

* Cost of plant excluding ancillary works.

BACKLOG MUNICIPAL WASTE TREATMENT NEEDS

January 1, 1963

IV. TOTAL

	Number	Population Served	Cost in Thousands		
			Plant	Ancillary Works	Total
Population Size Group					
Under 500	1,341	400,355	43,487	34,790	78,277
500 - 1,000	1,342	935,265	85,954	68,763	154,717
1,000 - 5,000	2,295	4,755,718	354,519	283,615	638,134
5,000 - 10,000	435	2,956,557	164,417	131,534	295,951
10,000 - 25,000	263	4,838,832	177,165	141,732	318,897
25,000 - 50,000	62	2,295,704	67,898	54,318	122,216
50,000 - 100,000	49	3,807,116	101,466	81,173	182,639
Over 100,000	44	15,877,811	211,159	210,427	421,586
States					
Alabama	92	367,200	16,074	12,859	28,933
Alaska	29	90,473	6,241	4,993	11,234
Arizona	29	133,473	5,586	4,469	10,055
Arkansas	94	237,379	13,129	10,503	23,632
California	269	2,025,285	85,668	68,534	154,202
Colorado	77	847,164	19,525	15,620	35,145
Connecticut	47	668,980	24,736	19,789	44,525
Delaware	3	3,309	284	227	511
District of Columbia	0	0	0	41,500	41,500
Florida	169	1,304,316	36,218	28,974	65,192
Georgia	112	512,314	21,413	17,130	38,543
Guam	19	68,251	3,901	3,121	7,022
Hawaii	9	48,800	4,827	3,862	8,689
Idaho	106	105,548	6,007	4,806	10,813
Illinois	237	930,124	47,463	37,970	85,433

			Cost in Thousands		
	Number	Population Served	Plant	Ancillary Works	Total
States					
Indiana	69	676,047	$ 20,028	$ 16,022	$ 36,050
Iowa	145	826,109	38,180	30,544	68,724
Kansas	100	416,148	10,549	8,439	18,988
Kentucky	83	201,601	14,827	11,862	26,689
Louisiana	139	1,181,149	34,365	27,492	61,857
Maine	60	364,368	21,587	17,270	38,857
Maryland	29	65,982	5,089	4,071	9,160
Massachusetts	60	758,951	23,822	19,106	42,988
Michigan		No Report	--	--	--
Minnesota	183	1,674,500	55,942	44,754	100,696
Mississippi	173	265,917	7,328	5,862	13,190
Missouri	469	5,173,863	77,734	62,187	139,921
Montana	51	118,830	3,221	2,577	5,798
Nebraska	93	297,612	12,370	9,896	22,266
Nevada	9	101,983	5,216	4,173	9,389
New Hampshire	72	237,400	15,174	12,139	27,313
New Jersey	82	544,216	34,064	27,251	61,315
New Mexico	43	85,901	4,024	3,219	7,243
New York	844	3,728,243	152,423	121,938	274,361
North Carolina	179	986,936	46,395	37,116	83,511
North Dakota	50	87,251	1,515	1,212	2,727
Ohio	79	647,430	20,918	16,734	37,652
Oklahoma	160	866,183	11,421	9,137	20,558
Oregon	100	334,410	27,224	21,779	49,003
Pennsylvania	398	1,640,953	86,750	69,400	156,150

IV. TOTAL - 1963

Page 3

	Number	Population Served	Cost in Thousands		
			Plant	Ancillary Works	Total
States					
Puerto Rico	8	52,575	$ 2,075	$ 1,660	$ 3,735
Rhode Island	16	603,350	9,611	7,689	17,300
South Carolina	69	1,052,932	23,280	18,624	41,904
South Dakota	143	223,535	6,684	5,347	12,031
Tennessee	39	834,439	21,041	16,833	37,874
Texas	179	2,226,334	28,718	22,974	51,692
Utah	45	71,127	5,010	4,008	9,018
Vermont	14	40,859	2,423	1,938	4,361
Virginia	64	296,220	9,935	7,948	17,883
Virgin Islands	4	16,350	1,780	1,424	3,204
Washington	76	883,725	24,985	19,988	44,973
West Virginia	108	315,400	26,027	20,822	46,849
Wisconsin	100	606,014	22,589	18,071	40,660
Wyoming	4	19,899	609	487	1,096
U. S. TOTALS	5,831	35,867,358	$1,206,065	$1,006,352	$2,212,417

These forecasts are illustrated by the figure on the following page.

The cost of providing additional waste treatment works to serve future populations has been estimated on the basis of present average per capita cost of $36.67 for constructing secondary sewage treatment facilities.

In order to arrive at the total of these required facilities, it was necessary to recognize that municipal waste treatment works currently in operation must eventually also be replaced because of obsolescence. For the purpose of estimating these replacement needs, an effective life of 25 years for treatment plants and 50 years for interceptor and outfall sewers has been assumed.

The 1962 PHS Inventory of Municipal and Industrial Waste Facilities discloses that there were 11,420 sewered communities in the United States on December 31, 1961. Of this number 9,281 provided some degree of treatment prior to discharge and 2,139 discharged their wastes without treatment.

MUNICIPAL WASTE TREATMENT FACILITIES* FOR THE
11,420 COMMUNITIES

1962

Type Treatment	Number Communities	Population Served
Minor	37	2,350,845
Primary	2,672	32,733,831
Intermediate	85	7,408,950
Secondary	5,236	58,996,094
Stabilization Ponds	1,348	2,195,258
Sub-Total	9,378	103,684,978
None	2,277	14,686,941
TOTAL	11,655	118,371,919

The cost of replacing the treatment plants reported in the 1962 inventory has been estimated at $3.041 billion, at 1961 construction prices. Contract award data for the past decade indicates that waste treatment plant construction makes up 55 percent of the total construction for waste treatment purposes, with associated interceptor and outfall sewers and other ancillary works making up the remaining 45 percent. Under the assumption that this relationship applies to all such existing treatment facilities, it is estimated that the replacement cost of the ancillary works would be $2.433 billion at 1961 prices.

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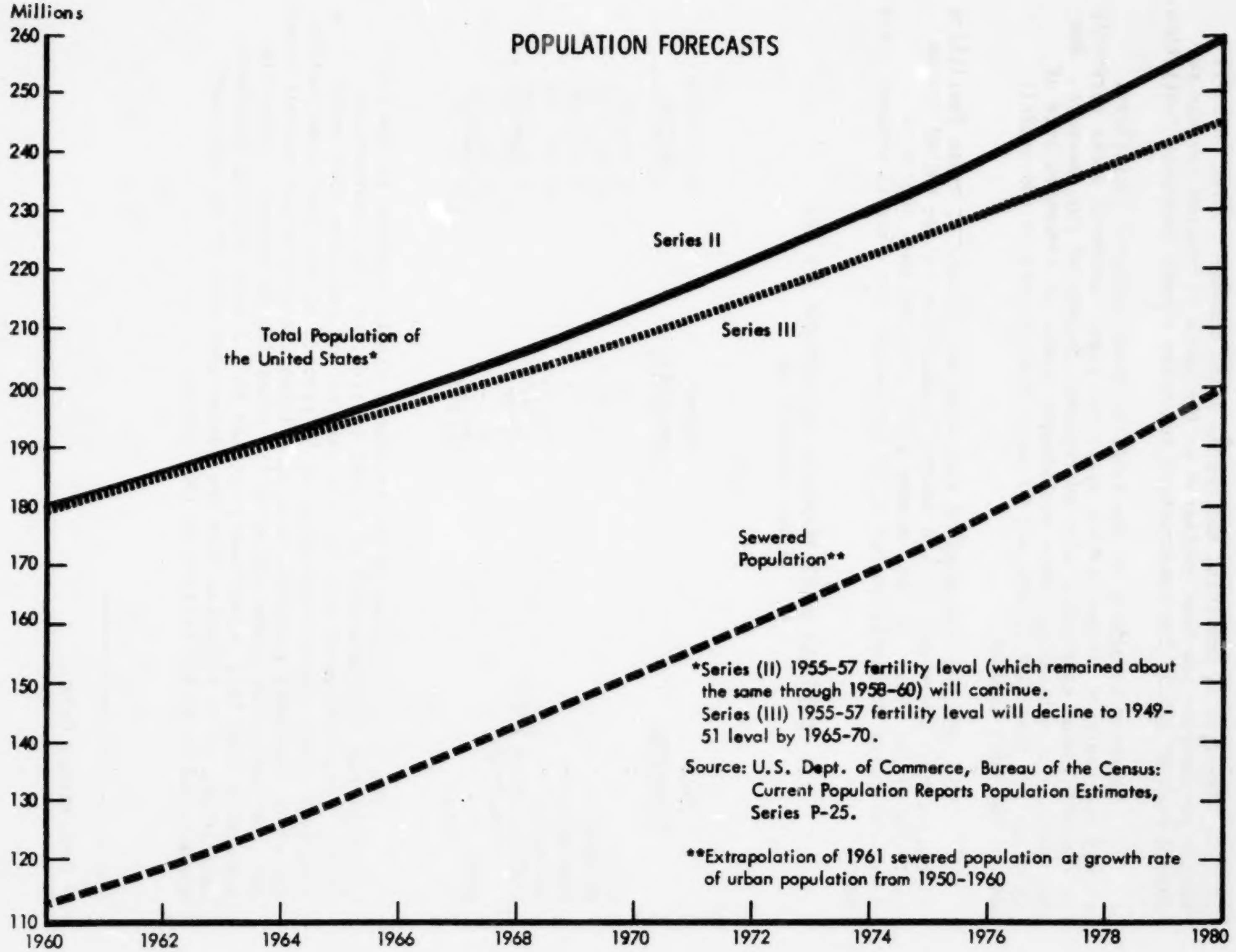
* Preliminary Data

POPULATION FORECASTS



*Series (II) 1955-57 fertility leval (which remained about the same through 1958-60) will continue.
Series (III) 1955-57 fertility leval will decline to 1949-51 leval by 1965-70.

Source: U.S. Dept. of Commerce, Bureau of the Census: Current Population Reports Population Estimates, Series P-25.

**Extrapolation of 1961 sewered population at growth rate of urban population from 1950-1960

Annual cost of replacing obsolete treatment plants is thus estimated at 4 percent of the $3.041 billion replacement cost of existing facilities. To this must be added the annual increments of cost required to reduce the backlog of needs and provide for population growth. Annual needs for ancillary facilities have been estimated at 2 percent of the $2.433 billion replacement value of existing facilities, plus the annual increment required to reduce the backlog of needs and provide for normal population growth.

The total annual construction rates required to eliminate the backlog of needed municipal waste treatment facilities and associated works, and to provide for continuing obsolescence and for population growth until 1980, are shown by the table and figure on the following pages. These rates are in 1963 dollars and do not reflect anticipated continuing increases in construction costs.

(c) Construction cost trends.

The Public Health Service Sewage Treatment Plant Construction Cost Index shows an average annual increase of about 2.3 percent for the period 1930 to 1963. The index has varied considerably from time to time because of war and the fluctuating economy and it is believed that the cost trends, subsequent to 1947 provide the best basis for future projections. Based on this latter period, an annual increase of 3.5 percent has been used in projecting future construction costs. The figure on page 210 shows the variations in the cost index since 1930 and projects the index to 1980 on the basis of the assumed annual increase of 3.5 percent.

(d) Estimated cost of needed waste treatment plants and associated facilities.

The estimated annual cost of constructing municipal waste treatment plants and related works based on 1963 prices is shown in the Table on page 211 and the Figure on page 212 . If construction costs continue to increase as in the past, these amounts would, of course, be much higher at the time of actual construction and the same figure and table show total annual construction costs for needed facilities in 1963 dollars, together with costs for these same facilities estimated on the basis of the projected increase in prices described above. The effect of such increases is illustrated in Table . The full significance of rising construction costs can be seen from an examination of the effect on a single construction rate over a specified period of time. The Table on page 214 shows that annual construction levels in the amount of an estimated $751 in 1963 dollars must be maintained through 1970 to eliminate the backlog by that date and keep abreast of new needs flowing from obsolescence and population growth. However, rising construction costs are expected to add substantially to this cost with the result that the 8-year construction program will cost $6,656 million instead of $6,008 million--an increase of nearly $648 million. Future planning must take this into consideration.

(e) Municipalities with combined sewer systems.

The control of pollution from municipal wastes is frequently complicated by the use of a single sewer system to carry both sewage and surface

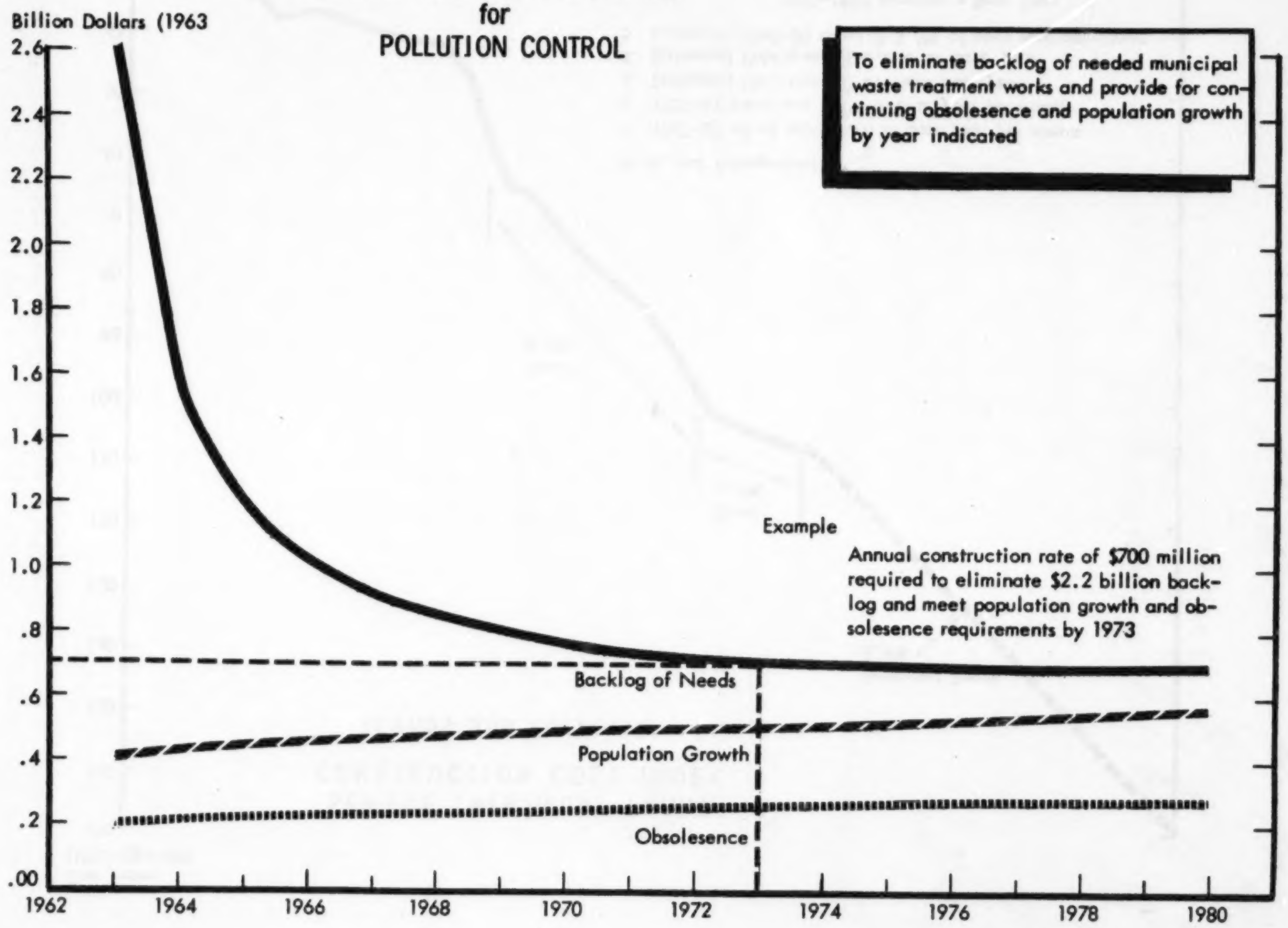
TABLE

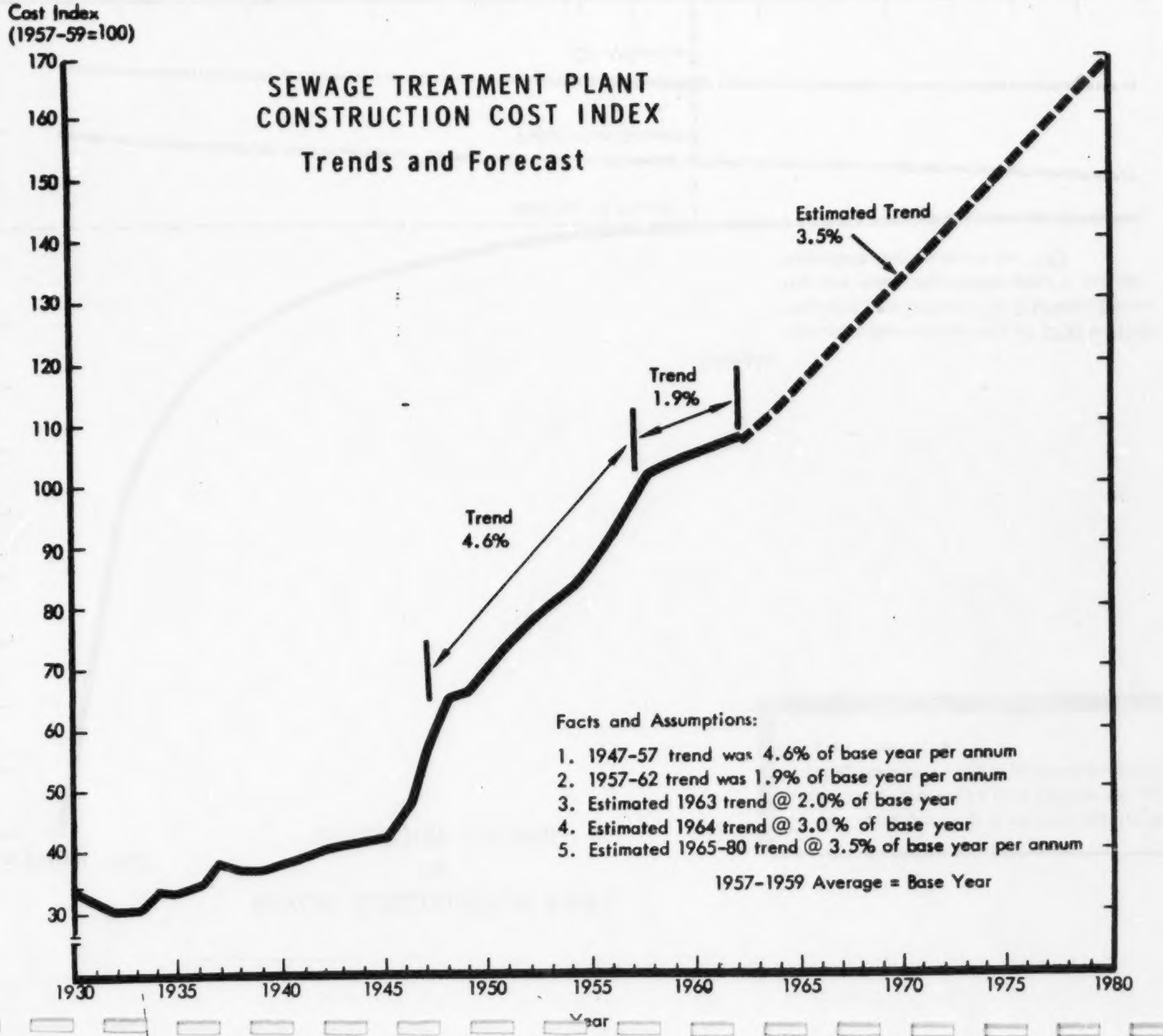
REQUIRED ANNUAL CONSTRUCTION RATES*
for
POLLUTION CONTROL

Control By	Construction Required in Millions of Dollars for			
Year	**Obsolescence**	**Population**	**Backlog**	**Total**
1963	184	212	2,212	2,608
1964	204	214	1,106	1,524
1965	214	219	737	1,170
1966	220	223	553	996
1967	225	227	442	894
1968	230	230	369	829
1969	235	233	316	784
1970	230	236	276	751
1971	243	240	246	729
1972	247	243	221	711
1973	250	247	201	698
1974	253	251	184	688
1975	256	256	170	682
1976	258	262	158	678
1977	260	269	147	676
1978	262	276	138	676
1979	263	283	130	676
1980	264	291	123	678

***Annual rates required to eliminate backlog of needed municipal waste treatment and facilities and associated ancillary works, and to provide for continuing obsolescense and population growth, by year indicated.**

ANNUAL CONSTRUCTION RATES
for
POLLUTION CONTROL





SEWAGE TREATMENT PLANT
CONSTRUCTION COST INDEX
Trends and Forecast

Facts and Assumptions:

1. 1947-57 trend was 4.6% of base year per annum
2. 1957-62 trend was 1.9% of base year per annum
3. Estimated 1963 trend @ 2.0% of base year
4. Estimated 1964 trend @ 3.0 % of base year
5. Estimated 1965-80 trend @ 3.5% of base year per annum

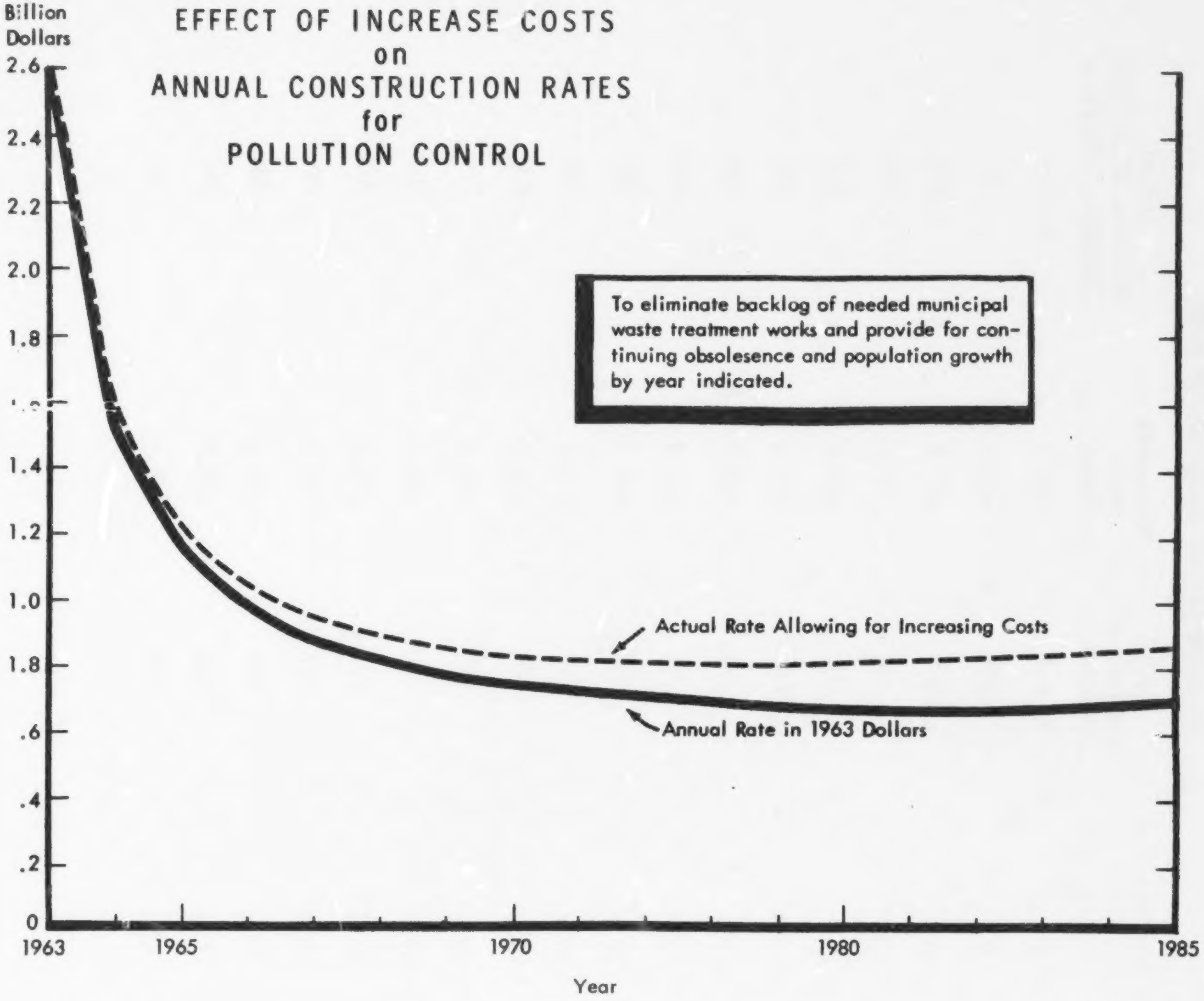
1957-1959 Average = Base Year

EFFECT OF RISING CONSTRUCTION COSTS
on
REQUIRED ANNUAL CONSTRUCTION RATES

Control by Year	1963 Millions of Dollars	Protected Cost Index	Actual Millions of Dollars (Annual Average)
1963	$2,608	109.3	$2,608
1964	1,524	112.3	1,545
1965	1,170	115.8	1,204
1966	996	119.3	1,040
1967	894	122.8	948
1968	829	126.3	892
1969	784	129.8	856
1970	751	133.3	832
1971	729	136.8	820
1972	711	140.3	811
1973	698	143.8	807
1974	688	147.3	806
1975	682	150.8	810
1976	678	154.3	816
1977	676	157.8	825
1978	676	161.3	836
1979	676	164.8	846
1980	678	168.3	860

April 26, 1963

EFFECT OF INCREASE COSTS
on
ANNUAL CONSTRUCTION RATES
for
POLLUTION CONTROL



To eliminate backlog of needed municipal waste treatment works and provide for continuing obsolesence and population growth by year indicated.

storm runoff. During periods of rainfall, these combined systems must carry many times their "dry weather flow," because of the storm water. It has not been considered economically feasible to build treatment plants to handle the entire flow of rainwater along with the sewage and the alternative has been to "bypass" to the receiving stream the combined discharge above some predetermined level. Sewage treatment plants serving such systems are frequently designed to handle about two times the dry weather flow. The combined flows would probably not be diverted to the stream at much less than three times dry weather flow, however, because of the storage capacity of the sewer system. Occasionally, storm water tanks or basins may be used to treat or hold bypassed combined sewage.

Previous studies[1] indicate that in the New England area combined sewers can be expected to overflow slightly more than five percent of the time during the summer months of June through September. This is equivalent to overflows 6 to 7 times per month. In a Detroit study[2] it was found that overflows would occur about 7 times per month on the average through the year. Recent studies[3] in Washington, D. C. included a 12-month period of gaging a number of overflow points which showed an overflow frequency of about 5 times per month.

Unfortunately, few statistically significant studies have been made to determine combined sewage composition and to evaluate the influence of combined overflows on stream pollution. In a recent survey[4] of the problem, it was reported that studies in Buffalo and New York City have indicated that receiving waters are frequently subject to large amounts of pollution from combined sewer systems following rainfall. One storm of only 0.08 inches and 15 minutes duration in Buffalo produced an overflow for 4 hours. Suspended solids equal to 1½ days accumulation of sewage overflowed during this period. In other words, for four consecutive hours, pollutants were entering the receiving stream at a rate equal to 9 times that which would have occurred had the City discharged all its sewage in an untreated state.

It does not appear, however, that the extent of pollution from combined system overflows is very well understood even by the cities involved. Questionnaires concerning this problem were recently sent to 148 cities having populations greater than 50,000. In answer to the question, "Have any studies been made of the relationship between concentration of BOD, or of settleable or suspended solids and (1) the rate of rainfall or (2) the duration of rainfall?" there were 41 negative replies to (1) and only one positive

---

[1] McKee, J.E., "Loss of Sanitary Sewage Through Storm Water Overflows," Jn. B.S.C.E., 34-2, 55

[2] Palmer, C.L., "The Pollutional Effects of Storm Water Overflows from Combined Sewers." Jn. WPCF 22, 2, 154 (Feb. 1950)

[3] Johnson, C.F., "Nations's Capitol Enlarges its Sewerage System." Civil Engineering, 28, 2, 56 (June 1958)

[4] Romer, Harold T.; Klashman, Lester M., "How Combined Sewers Affect Water Pollution, Public Works, March and April, 1963

TABLE

ANNUAL CONSTRUCTION REQUIRED
for
CONTROL of MUNICIPAL POLLUTION by 1970

Year	1963 Dollars (Millions)	Cost Index	Current Dollars (Millions)
1963	$ 751	109.3	$ 751
1964	751	112.3	771
1965	751	115.8	795
1966	751	119.3	819
1967	751	122.8	844
1968	751	126.3	868
1969	751	129.8	892
1970	751	133.3	916
TOTALS	$6,008		$6,656

reply without details. In answer to part (2), 40 replies were received, 37 being negative and 1 positive without details. To the question, "Have you analyzed the effect of combined sewer discharges to determine if they have a significant influence on the dissolved oxygen or coliform density of the receiving waters?" there were 43 replies with 34 negative. The question, "Do discharges from combined sewers present a significant pollution problem?" brought a better response. In 42 replies, 25 were negative and 17 affirmative. Typical among the latter, were: Lakewood, Ohio, which replied, "To some extent in the river. New plant to correct this;" Kansas City, Missouri, "Total flow obviously increased coliforms in public water supplies;" and Milwaukee, Wisconsin, which states, "Two beaches had to be closed."

Combined sewer systems unquestionably contribute significantly to water pollution. The problem, however, has not been well studied and is not sufficiently understood for proper assessment.

The correction of pollution problems caused by combined sewer systems may be as varied as the circumstance involved. In some situations, partial or complete separation may be the answer. In others, it may be the construction of holding tanks or treatment facilities for the overflow. Because of the many unknowns involved, the problem cannot be accurately defined at this time. There is sufficient evidence, however, to conclude that combined sewer systems are a major source of pollution which should be carefully studied and evaluated so that remedial steps can be taken. Further study should also be given to the effect of storm sewer discharges on the quality of receiving waters where separate systems are used. While not considered waste water in the usual sense, such flows can exert a marked polluting effect on streams because of the materials picked up in surface washings.

Combined sewer systems are used by 1305 U. S. municipalities for surface water drainage and sewage collection from a total population of 25.96 million (Table 1). An additional 618 municipalities with a total of 33.8 million population have part combined and part separate storm and sanitary sewer systems. Fortunately, the majority of U. S. communities are served by separate sewer systems. The following table shows 9,083 municipalities with 57.3 million population in the latter category.

NOTE: These three tables do not include 414 communities of 1.3 million population with undefined collection systems.

Municipalities with Combined Sewer Systems

	Number of Communities	Population Served
Population Size Group		
Under 500	52	16,959
500 - 1,000	167	117,971
1,000 - 5,000	591	1,159,195
5,000 - 10,000	175	908,516
10,000 - 25,000	170	1,870,565
25,000 - 50,000	73	1,909,950
50,000 - 100,000	48	2,258,960
Over 100,000	29	17,721,939
States		
Alabama	0	0
Alaska	0	0
Arizona	1	20,000
Arkansas	2	64,300
California	12	2,057,910
Colorado	1	107,000
Connecticut	16	490,919
Delaware	1	2,700
District of Columbia	0	0
Florida	2	21,500
Georgia	3	914,515
Hawaii	0	0
Idaho	10	48,905
Illinois	154	4,833,140
Indiana	202	2,445,065
Iowa	18	184,760
Kansas	1	107,000
Kentucky	27	658,620
Louisiana	0	0
Maine	39	198,650
Maryland	8	16,800
Massachusetts	37	931,760
Michigan	95	4,252,685
Minnesota	29	1,185,710
Mississippi	0	0
Missouri	6	44,945
Montana	4	19,600

Municipalities with Combined Sewer Systems
Cont'd

	Number of Communities	Population Served
States		
Nebraska	13	26,790
Nevada	4	80,600
New Hampshire	28	91,350
New Jersey	15	366,375
New Mexico	0	0
New York	53	519,525
North Carolina	1	1,020
North Dakota	48	196,855
Ohio	123	1,735,680
Oklahoma	0	0
Oregon	37	610,280
Pennsylvania	158	707,915
Puerto Rico	0	0
Rhode Island	1	0
South Carolina	0	0
South Dakota	20	15,925
Tennessee	5	195,125
Texas	1	55,000
Utah	0	0
Vermont	7	8,555
Virginia	1	180,000
Washington	42	825,505
West Virginia	47	425,471
Wisconsin	33	1,315,600
Wyoming	0	0
U.S. TOTALS	1,305	25,964,055

Municipalities with Combined and Separate Sewer Systems

	Number of Communities	Population Served
Population Size Group		
Under 500	13	3,530
500 - 1,000	31	21,810
1,000 - 5,000	220	448,131
5,000 - 10,000	130	768,117
10,000 - 25,000	97	1,245,242
25,000 - 50,000	64	1,893,277
50,000 - 100,000	27	1,783,605
Over 100,000	36	27,672,315
States		
Alabama	0	0
Alaska	13	58,360
Arizona	0	0
Arkansas	0	0
California	0	0
Colorado	0	0
Connecticut	8	421,900
Delaware	6	238,520
District of Columbia	1	1,323,470
Florida	0	0
Georgia	2	268,920
Hawaii	0	0
Idaho	2	9,200
Illinois	29	1,835,280
Indiana	3	36,040
Iowa	10	402,350
Kansas	3	176,400
Kentucky	5	41,445
Louisiana	0	0
Maine	31	210,608
Maryland	3	2,500
Massachusetts	14	2,828,605
Michigan	67	1,292,275
Minnesota	1	19,690
Mississippi	1	18,600
Missouri	20	1,411,960
Montana	7	65,940

Municipalities with Combined and Separate Sewer Systems
Cont'd

	Number of Communities	Population Served
States		
Nebraska	5	245,150
Nevada	0	0
New Hampshire	27	144,200
New Jersey	3	1,311,185
New Mexico	0	0
New York	49	10,192,945
North Carolina	0	0
North Dakota	0	0
Ohio	56	3,110,420
Oklahoma	0	0
Oregon	6	43,100
Pennsylvania	113	6,144,115
Puerto Rico	0	0
Rhode Island	2	386,470
South Carolina	0	0
South Dakota	7	19,170
Tennessee	1	142,100
Texas	1	58,100
Utah	0	0
Vermont	34	165,812
Virginia	4	181,050
Washington	13	302,030
West Virginia	19	87,970
Wisconsin	52	640,147
Wyoming	0	0
U.S. TOTALS	618	33,836,027

Municipalities with Separate Sewer Systems

	Number of Communities	Population Served
Population Size Group		
Under 500	1110	334,126
500 - 1,000	1545	1,013,334
1,000 - 5,000	4042	8,014,501
5,000 - 10,000	1070	5,893,827
10,000 - 25,000	856	9,619,776
25,000 - 50,000	273	6,264,500
50,000 - 100,000	119	6,070,000
Over 100,000	68	20,098,985
States		
Alabama	162	1,493,218
Alaska	8	3,260
Arizona	63	689,734
Arkansas	129	705,285
California	507	9,359,536
Colorado	164	1,309,431
Connecticut	46	574,837
Delaware	13	25,158
District of Columbia	0	0
Florida	283	2,111,239
Georgia	216	1,083,157
Hawaii	19	362,166
Idaho	78	244,894
Illinois	360	1,227,256
Indiana	85	364,915
Iowa	384	983,090
Kansas	308	1,180,005
Kentucky	124	563,080
Louisiana	124	2,095,553
Maine	31	68,720
Maryland	97	1,327,134
Massachusetts	117	619,165
Michigan	121	570,100
Minnesota	400	857,145
Mississippi	135	755,056
Missouri	333	1,065,225
Montana	104	299,680

Municipalities with Separate Sewer Systems
Cont'd

States	Number of Communities	Population Served
Nebraska	274	517,470
Nevada	32	233,430
New Hampshire	15	45,660
New Jersey	238	2,314,640
New Mexico	66	599,821
New York	346	2,709,148
North Carolina	286	1,742,940
North Dakota	127	118,930
Ohio	263	1,856,930
Oklahoma	263	1,438,724
Oregon	104	270,110
Pennsylvania	578	2,687,262
Puerto Rico	70	121,634
Rhode Island	23	174,385
South Carolina	154	927,114
South Dakota	154	343,162
Tennessee	124	1,122,268
Texas	662	6,486,007
Utah	89	695,635
Vermont	5	8,390
Virginia	172	1,481,817
Washington	125	373,650
West Virginia	99	168,460
Wisconsin	335	712,268
Wyoming	68	221,155
U.S. TOTALS	9,083	57,309,049

(f) Estimated cost of separating combined sewer systems.

The separation of a large combined sewer system into separate systems is a project of vast proportions. In some cases, new sanitary sewers would be required, leaving the existing combined sewers for storm water. For complete separation of combined sewers, the plumbing system within each building would also have to be rearranged so that roof leaders and areaway, depressed driveway, and cellar drains would all discharge through the building connection into the storm drain, and the sanitary sewage would discharge into another connection leading to the separate sanitary sewer. In the highly developed urban areas, new sanitary sewers would probably be built in city streets beneath which are electric conduits, water mains, gas mains, telephone and telegraph conduits, sewers, and the building-service connections for the various utilities. This situation, together with heavy traffic, would increase the difficulties and expense of construction.

One alternate and less costly solution, in some cases, at least, would be to provide storage basins or treatment for storm overflows. In such a system, when the combined storm water-sewage flow exceeded the capacity of the combined sewerage system the excess would be taken off at the overflow structure and retained in storage basins for treatment at the municipal plant as the flow ebbed and treatment capacity became available, or at special treatment units designed for this purpose.

The difficulty in attempting to determine a unit cost for the separation of combined sewer systems is evident when some of the variables are examined. These might include: population density, topography, urban development, industrial development, subsurface structural conditions, transportation problems, and other factors. Various units have been used to express the unit cost for separation of combined sewers. In the smaller communities this is generally expressed in dollars per capita. In the larger municipalities it may be expressed in dollars per unit of sewered area or dollar per unit length of sewer. General estimates of per capita costs for the complete separation of combined sewer systems in several U. S. cities (P.H.S. Survey) are presented in the following table.

ESTIMATED COSTS FOR COMPLETE SEPARATION
of
COMBINED SEWER SYSTEMS
PER CAPITA BASIS

City	Cost per capita 1963 Dollars
Concord, New Hampshire	$280
Dardanelle, Arkansas	143
Detroit, Michigan	234
Elmhurst, Illinois	200
Milwaukee, Wisconsin	215
Seattle, Washington	320
Texas City, Texas	125
Washington, D. C.	161

The following table shows estimated unit costs for separation of combined sewer systems within the larger metropolitan areas.

ESTIMATED COSTS FOR COMPLETE SEPARATION of COMBINED SEWER SYSTEMS PER ACRE BASIS

City	Cost per Acre 1963 Dollars
Chicago, Illinois (Exclusive of Sanitary District)	$17,000
Milwaukee, Wisconsin	10,100
New York, New York	30,000
San Francisco, California (Bay Area)	2,500
Seattle, Washington	4,000
Washington, D. C.	18,000

The problem of estimating the cost of separating combined sewer systems is further complicated by the fact that the actual population served by combined systems in cities having both combined and separate systems is not to well known. For estimating purposes, it will be assumed that one-half of the population in these municipalities is served by combined systems.

It is recognized that no accurate estimate of the cost of separating combined sewer systems can be made because of the dearth of information presently available. Nevertheless, some understanding of the magnitude of the cost is desirable and a rough estimate has therefore been made, using a per capita cost of $200 and populations of 25,849,305 served by combined systems and one-half of 33,129,307 served by mixed systems. On this basis, the total cost of eliminating combined sewers is estimated at $8.5 billion. The following table presents a breakdown of this estimate by States.

TABLE I

ESTIMATED COST * OF SEPARATION OF COMBINED SEWER SYSTEMS

State	Population Served Combined Systems	 One-Half Mixed Systems	 Estimated Total Combined	Estimated Cost (Millions 1963 Dollars)
Alabama	0	0	0	0
Alaska	0	29,180	29,180	5.8
Arizona	20,000	0	20,000	4.0
Arkansas	64,300	0	64,300	12.9
California	2,057,910	0	2,057,910	411.6
Colorado	107,000	0	107,000	21.4
Connecticut	490,919	210,950	701,869	140.4
Delaware	2,700	119,260	121,960	24.4
Dist. of Columbia	0	661,735	661,735	132.3

Estimated Cost*
Separation of Combined Sewer Systems
Continued

	Population Served			
State	Combined Systems	One-Half Mixed Systems	Estimated Total Combined	Estimated Cost (Millions 1963 Dollars
Florida	21,500	0	21,500	4.3
Georgia	914,515	134,460	1,048,975	209.8
Hawaii	0	0	0	0
Idaho	48,905	4,600	53,505	10.7
Illinois	4,833,140	917,640	5,750,780	1,150.2
Indiana	2,445,065	18,020	2,463,085	492.6
Iowa	184,760	201,175	385,935	77.2
Kansas	107,000	88,200	195,200	39.0
Kentucky	658,620	20,722	679,342	135.9
Louisiana	0	0	0	0
Maine	198,650	105,304	303,954	60.8
Maryland	16,800	1,250	18,050	3.6
Massachusetts	931,760	1,414,302	2,346,062	469.2
Michigan	4,252,685	646,137	4,898,822	979.8
Minnesota	1,185,710	9,845	1,195,555	239.1
Mississippi	0	9,300	9,300	1.9
Missouri	44,945	705,980	750,925	150.2
Montana	19,600	32,970	52,570	10.5
Nebraska	26,790	122,575	149,365	29.9
Nevada	80,600	0	80,600	16.1
New Hampshire	91,350	72,100	163,450	32.7
New Jersey	366,375	655,592	1,021,967	204.4
New Mexico	0	0	0	0
New York	519,525	5,096,472	5,615,997	1,123.2
North Carolina	1,020	0	1,020	0.2
North Dakota	196,855	0	196,855	39.4
Ohio	1,735,680	1,555,210	3,290,890	658.2
Oklahoma	0	0	0	0
Oregon	610,280	21,550	631,830	126.4
Pennsylvania	707,915	3,072,057	3,779,972	755.9
Puerto Rico	0	0	0	0
Rhode Island	0	193,235	193,235	38.6
South Carolina	0	0	0	0
South Dakota	15,925	9,585	25,510	5.1
Tennessee	195,125	71,050	266,175	53.2
Texas	55,000	29,050	84,050	16.8
Utah	0	0	0	0
Vermont	8,555	82,906	91,461	18.3
Virginia	180,000	90,525	270,525	54.1
Washington	825,505	151,015	976,520	195.3
West Virginia	425,471	43,985	469,456	93.9
Wisconsin	1,315,600	320,073	1,635,673	327.1
Wyoming	0	0	0	0
	25,964,055	16,918,014	42,882,069	8,576.4

* At $200/capita

(g) Communities without sewage collection systems.

There is no available information conerning the sewage collection system needs of all incorporated communities in the U. S. The Conference of State Sanitary Engineers Survey reports all unsewered communities presently requiring sewer systems for public health reasons. The needs of other unsewered communities and unsewered populations in urban areas have not been defined. It seems reasonable to assume, however, that sewage collection systems are desirable in all areas served by public water systems. The urban population served by public water systems, but not by public sewer systems, is shown by State in the table on the following page. This does not include cities over 50,000 population.

(h) Estimated cost of sewage collection systems.

The cost of providing sewage collection systems for unsewered populations served by public water systems has been estimated at $125 per capita. This shown by State in the table on the following page. The total estimated cost for the U. S. as a whole is $2.5 billion.

SEWAGE COLLECTION SYSTEM NEEDS

STATES	POPULATION[1]	COST[2] (Thousands Dollars)
U. S. TOTALS	20,233,221	2,529,153
Alabama	477,019	59,627
Alaska	15,194	1,899
Arizona	199,147	24,893
Arkansas	206,764	25,846
California	1,470,931	183,866
Colorado	141,281	17,660
Connecticut	492,595	61,574
Delaware	26,464	3,308
District of Columbia		
Florida	1,479,349	184,919
Georgia	643,645	80,456
Hawaii	155,721	19,465
Idaho	129,722	16,215
Illinois	634,636	79,330
Indiana	362,603	45,325
Iowa	182,260	22,783
Kansas	205,317	25,665
Kentucky	428,190	53,524
Louisiana	595,007	74,376
Maine	165,757	20,720
Maryland	200,057	25,007
Massachusetts	1,129,949	141,244
Michigan	475,337	59,417
Minnesota	26,257	3,282
Mississippi	266,710	33,339
Missouri	403,889	50,486
Montana	76,342	9,543
Nebraska	86,862	10,858
Nevada	23,710	2,964
New Hampshire	97,772	12,222
New Jersey	769,865	96,233
New Mexico	77,118	9,640
New York	1,963,354	245,419
North Carolina	312,092	39,012
North Dakota	3,466	433

Sewage Collection System Needs
Page 2

States	Population[1]	Cost[2] (Thousands Dollars)
U. S. Totals		
Ohio	666,862	83,358
Oklahoma	222,613	27,827
Oregon	477,343	59,668
Pennsylvania	1,348,667	168,582
Rhode Island	208,147	26,018
South Carolina	351,822	43,978
South Dakota	29,730	3,716
Tennessee	712,008	89,001
Texas	781,498	97,637
Utah	141,144	17,643
Vermont	51,999	6,500
Virginia	321,523	40,190
Washington	702,742	87,843
West Virginia	267,587	33,448
Wisconsin	1,339	167
Wyoming	23,815	2,977

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[1] Urban population served by public water supply systems but not by public sewer systems excluding incorporated areas of over 50,000 population.

[2] Estimated cost of sewering unsewered areas served by public water systems at $125/capita.

Enforcement

The primary responsibility for controlling water pollution rests with the States. Although State statutes generally provide adequate enforcement authority, most of the State water pollution control agencies have not, in the past, pursued effective enforcement programs.

It is expected that as population and industry continue to grow, metropolitan complexes continue to increase in number and size, and technology continues to change, pollution problems can be expected to continue to increase in number, scope and complexity. These circumstances will pose great challenges to the municipalities, industries and others responsible for constructing, operating and maintaining treatment and control facilities. They will also greatly challenge the State regulatory agencies. Based on past experience, it can be anticipated that increased enforcement activities will be required to control the existing backlog of pollution situations and those that will develop in the immediate years ahead.

The future scope of the Federal enforcement program will depend largely on the extent to which the States are successful in controlling water pollution. It is reasonable to assume that the States will continue to invite Federal participation in the more difficult pollution situations, and that as these situations multiply in the future, more Federal support will be required. In those situations where the States are unable or unwilling to proceed with the necessary enforcement measures, direct Federal action under the increased jurisdiction provided in the 1961 Amendments would be indicated.

It does not seem reasonable to believe that the future quality of the Nation's water resources will be allowed to be deteriorated from past neglect and new pollution for lack of enforcement actions. Effective water pollution programs should be planned and carried out, but solidly behind these should be a strong enforcement policy, instituted whenever necessary.

BASIC DATA ACTIVITIES

The report of the Committee on Environmental Health Problems (Gross Committee) appraised the present situation and provided a look into the future when it said:

> "Basic water pollution data need to be collected, evaluated, and distributed on a cooperative basis among the water resource agencies concerned. To make these data more reliable, they need to be collected on a continuing basis in all the river basins; to make them more usable they need to be made available widely. We need to know where and why we are gaining or losing ground in controlling pollution, and to maintain a water intelligence that will detect pollution situations as they arise before they become major problems. Progress has been made, but basic data collection and evaluation programs still need to be greatly accelerated by all water pollution control agencies--local, State, interstate, and Federal. Most agencies require increased appropriations before this can be done."

Inventory Activities

The present method of collecting inventory information depends entirely on the abilities and cooperation of State agencies. In many States, it has been and it is becoming increasingly difficult to assemble and make available to the Public Health Service the data needed for these inventories. This is because of increased program responsibilities of the State agencies without increased resources; in some States there has even been a reduction in technical staffs. The Federal program should be expended sufficiently to enable the Public Health Service to assign personnel to the States to meet this need.

Probably the most serious void in data collection nationally is the almost complete lack of factual and up-to-date information on industrial wastes. For reasons of competition and possible regulatory actions at the State or Federal level, industries as a whole have not made avilable to the States or Federal agencies inventory information on industrial water use, quantities and contents of industrial wastes discharged to surface waters, or the kinds and degree of treatment, if any, given to the wastes before discharge. In our rapidly expanding economy, with thousands of new products and wastes being created annually and discharged to surface waters, it is obvious that adequate corrective measures cannot be effected until an assessment is made of the extent of the industrial waste problem created. The Senate Select Committee on National Water Resources summarized this problem in saying:

> "Data covering waste discharges from municipal sources are essentially complete, while data on industrial waste characteristics and volumes are notably lacking. The overall industrial production index is conservatively estimated to increase from 134 in 1954 to 767 by the year 2000. Proper orientation of overall water supply and pollution control program planning must be based on adequate information about current conditions. Basic data collection and evaluation must be continued and expended to enable responsible agencies to carry out comprehensive programs for water quality control."

In the 1957 Inventory of Municipal and Industrial Waste Treatment Facilities, the percentage of industries covered in the Nation as a whole was very small. Since it was not possible for the States to provide more complete coverage in the 1962 Waste Treatment Inventory, it was decided to limit that inventory to only municipal waste treatment facilities.

It is imperative that adequate data on the extent and complexity of the industrial waste problem be collected. Toward that end, negotiations with two States are being undertaken on a pilot basis to determine the feasibility of having State personnel collect the industrial waste data, and the Public Health Service list, evaluate, and publish it. In one of these States, temporary help was hired for this purpose, and a complete survey of the State made, including a listing of every industry. No attempt was made to determine the character of the discharged wastes themselves, however, but only to list the quantities discharged and type of treatment afforded. The Public Health Service is currently evaluating these data, preparatory to publication. In the second State, assistance was provided by the assignment of a professional staff person to work with State personnel in making an industrial waste survey. In this case some waste characteristics were obtained from a number of industries, but the survey did not cover all of the industries of the State.

The inventory data collection activity of the Public Health Service must be expanded to assist the States in this endeavor until full national coverage is achieved. Until this is accomplished, no really effective knowledge will be available upon which to base reliable decisions for managing water quality in meeting the Nation's needs.

Water Quality Data Collection

Future water quality data activities will place greater emphasis upon support of the Public Health Service's operating programs. As more of such programs get underway, it is becoming increasingly important to design data collection activities to provide information necessary in conducting comprehensive river basin planning, enforcement studies, and special technical projects. With the completion of comprehensive basin programs, the carrying-out of enforcement schedules, and increased amounts of Federal construction grants, it is necessary to maintain continuing surveillance in order to measure progress and make day-to-day operating decisions.

Because of growing concern over the need to coordinate Federal water quality data acquisition, it is expected that the Bureau of the Budget will soon issue a Circular outlining and directing how such coordination will be accomplished. This may also require some changes in the present pollution water quality data program.

Continuous Monitoring Equipment

Thus far sampling stations have been located where local personnel and laboratory facilities have been available for operating them. In many areas of the country, however, there is a need to locate stations at remote points on river systems, points too far away for periodic sample collection by local personnel. This creates a need for automatic detection and recording equipment in such places. Manufacturers have been encouraged to develop equipment to meet these needs, following guidelines and recommendations based on the experience gained in the Public Health Service's data collection activities.

Remoteness of location is not the only reason for needing automatic sampling and recording instruments. Past data collection activities have indicated a real need for continuous water quality monitoring on certain streams. The Public Health Service has a responsibility for obtaining continuous records of the quality of interstate waters in connection with its comprehensive planning projects and enforcement cases. Continuous monitoring of streams will require the installation and operation of automatic instrumentation. Continuous records provide much more information on variations in water quality than can be obtained from the regular grab samples normally taken.

TECHNICAL ASSISTANCE

Through its technical assistance activities, the Public Health Service provides aid to State, interstate and local agencies, industry and others, to help solve problems which exceed their staff or facilities. Requests for technical assistance can be expected to continue in the future, but it is anticipated that the kinds of assistance requested will change in nature.

The Public Health Service conducts a number of activities such as technical training, conferences and seminars on special subjects, demonstrations and the awarding of training grants and fellowships as means of increasing the technical proficiency of State, interstate and local personnel. These programs will become substantially increased as the regional research laboratories come into operation, making the training and demonstration programs more accessable to personnel in all parts of the Nation and more adapted to their specific needs.

Increased competency will enable State and local personnel to more effectively translate research findings and technical knowledge into working programs. Thus personnel at these levels will be able to cope with many of the more conventional, relatively localized problems which currently generate requests for Public Health Service technical assistance. This will free the personnel of the Service to direct more of their attention to newer, problems requiring skills of a more specialized nature, and problems of a wider regional or interstate character.